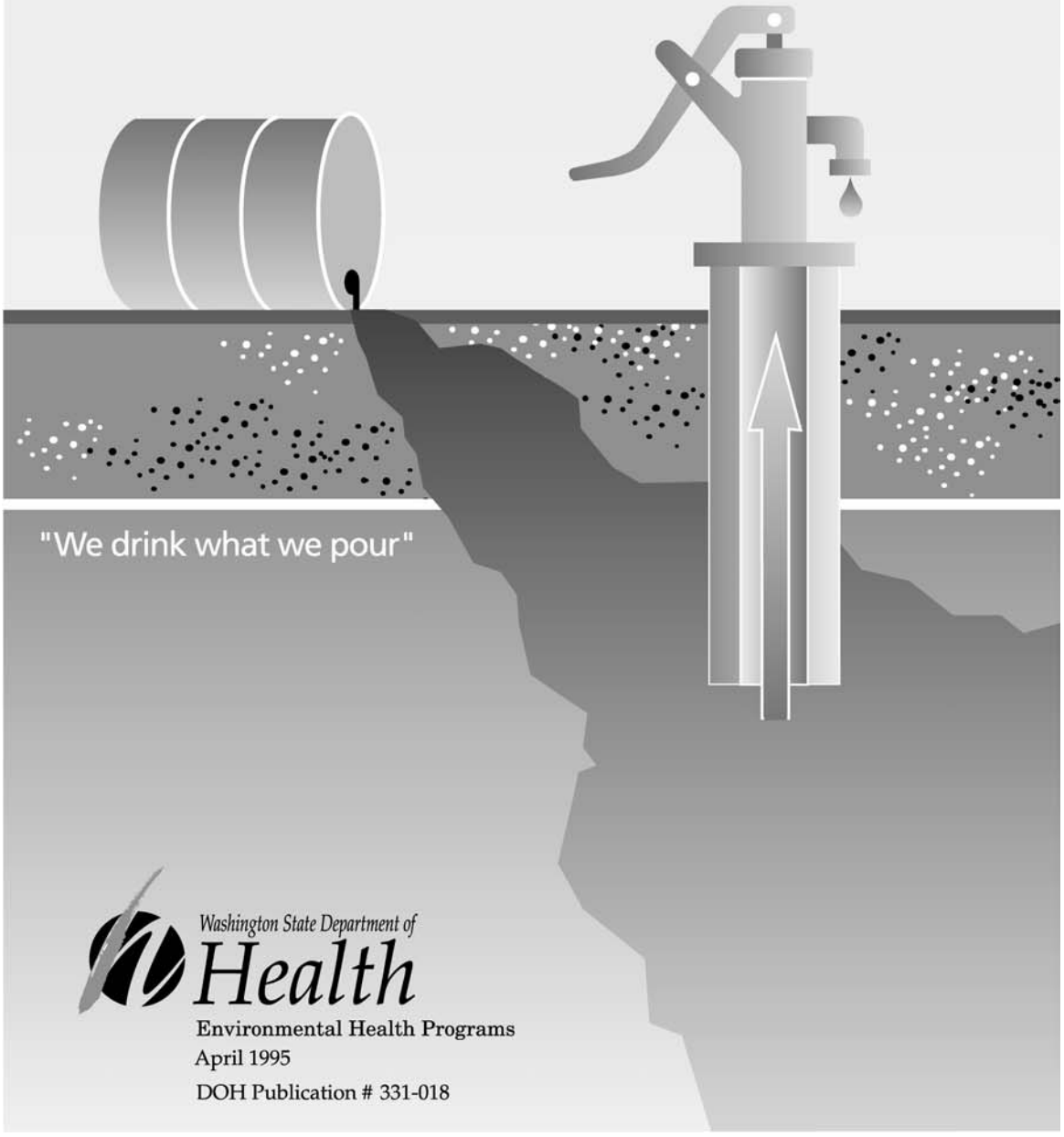
WASHINGTON STATE

Wellhead Protection Program Guidance Document



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Washington State
Wellhead Protection Program
Guidance Document

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For more information or additional copies of this report, contact:

Wellhead Protection Program
Department of Health
Airdustrial Bldg 3
PO Box 47822
Olympia WA 98504-7822

(360) 236-3149
(360) 236-2253 fax

Acknowledgments

One of the rewarding aspects of developing a state wellhead protection program is that it is a program which makes good sense. The U.S. EPA has produced generic guidelines, but an effective state program requires thoughtful and detailed input from a wide variety of individuals and organizations. The Washington State Wellhead Protection Program has been very fortunate in receiving such guidance.

The number of individuals who have helped shape Washington's proposed program are too numerous to list in entirety. There are some that deserve individual recognition. Within EPA Region 10, Bill Mullen, Roger Mochnick, Scott Downey and Martha Sabol have been extremely supportive. Doug Rushton and Marilyn Blair with the Washington State Department of Ecology's Water Resources Program, Bert Bowen with Ecology's Water Quality Program, and Lynn Helbrecht with Ecology's Hazardous Waste and Toxics Reduction Program have all offered valuable input and assistance. Carolyn Boatsman of the City of Renton, Heather Saunders of the Thurston County Health Department, and Trudy Rolla of the Seattle/King County Department of Public Health, have provided valuable insights on implementation from a local government perspective, as well as helping develop some of the most comprehensive local ground water protection programs in the entire county.

During the development of the Washington State plan, the Washington State Wellhead Protection Program was in contact with numerous other state wellhead protection programs. Special thanks and recognition to Alabama, Idaho, Massachusetts, Minnesota, Nebraska, North Dakota, Ohio, Oklahoma, and Oregon.

Members of both the Policy Advisory Committee and the Technical Advisory Committee deserve credit for their participation, patience, and valued input. Please reference Chapter 12 for a complete listing of committee members.

The Northwest Section of the American Water Works Association has been a strong promoter of wellhead protection and has jointly sponsored wellhead protection workshops with DOH.

Within DOH, two individuals must be singled out for their contributions. Ginny Stern, DOH's hydrogeologist, has been an invaluable technical and policy resource-particularly in areas of susceptibility assessments and implementation issues. Tikva Breuer, one half of Washington's Wellhead Protection Office, has invested countless hours preparing technical assistance documents, editing and improving the proposed plan, and working with local governments.

Finally, it is important to acknowledge all of the purveyors, local governments, and consultants currently implementing wellhead protection programs in Washington. Their efforts and insights have provided valuable feedback during state program development.

David G. Jennings
Wellhead Protection Program Manager

Acronyms and Abbreviations

BMPs	Best Management Practices
CARA	Critical aquifer recharge area
CCWF	Centennial Clean Water Fund
CTED	Washington State Department of Community Trade and Economic Development
DOH	Washington State Department of Health
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
ESA	Environmentally sensitive area
GMA	Growth Management Act
GWI	Ground water under influence of surface waters
GWMA	Ground water management area
LEPC	Local Emergency Planning Committee
LHD	Local health department
NRCS	Natural Resources Conservation Service
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
SARA Title III	Superfund Act Reauthorization Amendments
SDWA	Safe Drinking Water Act
SEPA	State Environmental Policy Act
SOP	Standard operating procedures
SRF	State Revolving Fund
SSA	Sole Source Aquifer
UIC	Underground Injection Control Program
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WAC	Washington Administrative Code
WSCC	Washington State Conservation Commission
WSDA	Washington State Department of Agriculture
ZOC	Zone of contribution

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Executive Summary

Overview

Section 1428 of the 1986 Amendments to the Federal Safe Drinking Water Act mandates that every state develop a wellhead protection program. In Washington State, the Governor designated the State Department of Health (DOH) as lead agency for wellhead protection program development and administration. The Safe Drinking Water Act required that all federally defined public water systems (Group A systems[1]) using ground water as their source implement a wellhead protection program. In July of 1994, the Washington Administrative Code addressing requirements for Group A public water systems (WAC 246-290) was modified to include mandatory wellhead protection measures for all Group A public water systems in the state using wells or springs (excluding systems using purchased sources, or interties) as their source of supply. In Washington State, local wellhead protection programs shall, at a minimum, include the following elements:

- A completed susceptibility assessment;
- A delineated wellhead protection area for each well, wellfield, or spring;
- An inventory within the wellhead protection area of all potential sources of contamination that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring, or wellfield;
- Documentation that delineation and inventory findings are distributed to required entities;
- Contingency plans for providing alternate sources of drinking water in the event that contamination does occur; and
- Coordination with local emergency responders for appropriate spill / incident response measures.

Program Goal

To prevent contamination of the ground water used by Group A public water systems.

Types of Systems Affected

All Group A water systems (excluding systems using purchased sources, or interites) that use wells or springs as a source of supply.

[1] DOH uses the term "Group A" to designate those public water systems which meet the federal definition of a public water system. This includes all public water systems which serve 25 or more persons or 15 or more connections. Please reference WAC 246-290-020 for more details.

Wellhead Protection Area Delineation Methods

Chapter 246-290 Washington Administrative Code (WAC), the drinking water regulations for Group A systems, was modified in May 1994 by the State Board of Health to explicitly require wellhead protection measures. July 1994 established the beginning date for compliance (**Figure 1**). By July 1995 all ground water based Group A systems were required to complete a DOH susceptibility assessment form.

The DOH susceptibility assessment includes an assessment of the circularity of the zone of contribution. The findings from the assessment, plus system size, determine the minimum acceptable wellhead protection area delineation method. For most systems, a Calculated Fixed Radius method may be employed.

Systems using the Calculated Fixed Radius method are expected to complete the initial delineation, including boundary mapping, by July of 1995. Systems using more sophisticated site-specific modeling approaches were expected to complete the initial delineation by July of 1996.

Wellhead Protection Area Zones

The primary zones of a wellhead protection area are defined using a time of travel of ground water criteria. The three principal zones are delineated using 1, 5, and 10 year time of travel factors. The two other zones are the currently existing sanitary control area and an additional buffer zone (if warranted). Varying management strategies for pollution prevention and risk reduction will be applied to address different types of contaminant threats. The wellhead protection area consists of:

The sanitary control area as defined in WAC 246-290-135.

Zone 1: the one (1) year horizontal time of travel boundary for ground water. Zone 1 is managed to protect the drinking water supply from viral, microbial and direct chemical contamination.

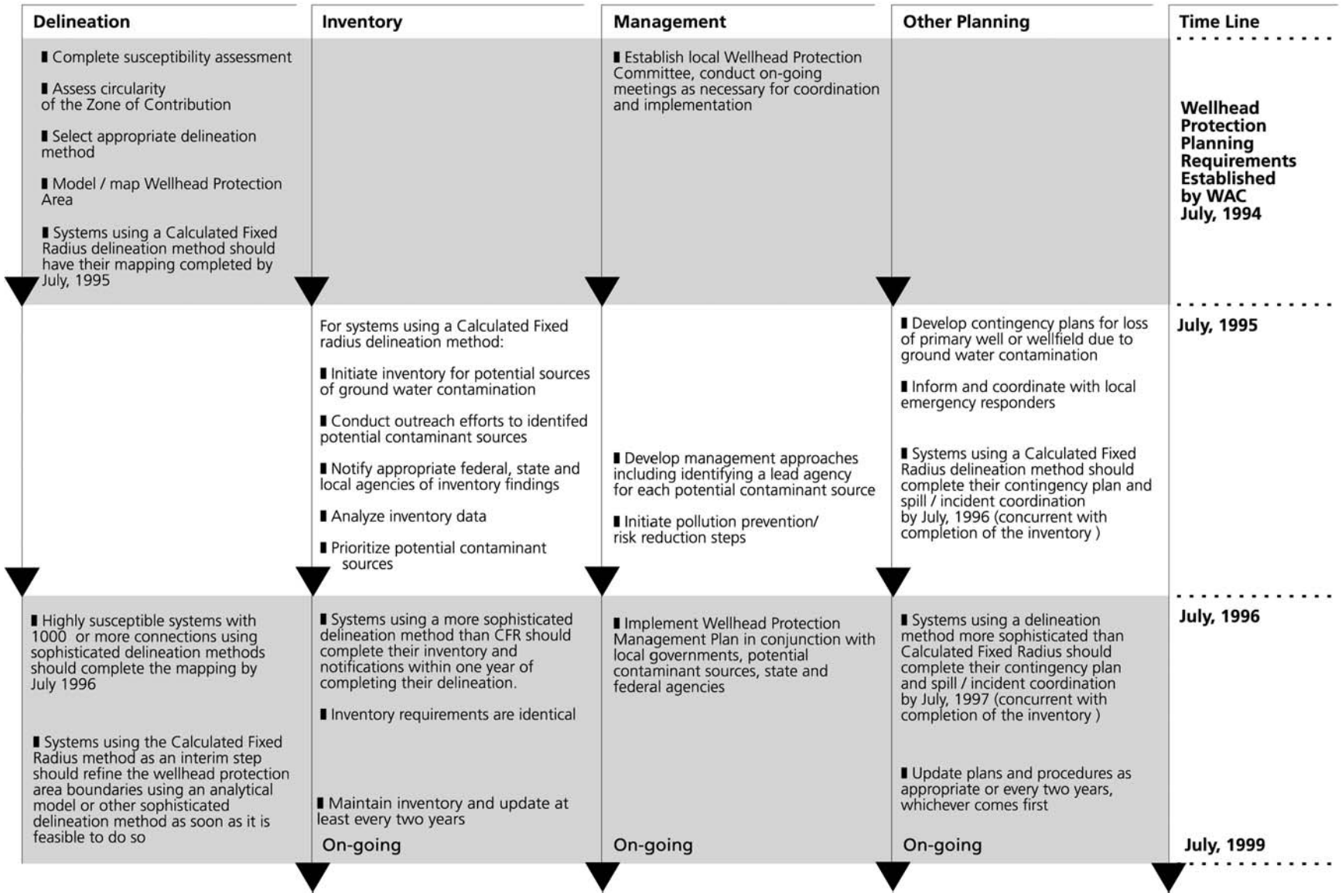
Zone 2: the five (5) year time of travel boundary should be actively managed to control potential chemical contaminants. All potential contaminant sources shall be addressed, with an emphasis on pollution prevention and risk reduction management. An important purpose of Zone 2 is to provide information to local planners when siting future "high risk" and "medium risk" potential contaminant sources.

Zone 3: the ten (10) year time of travel boundary determines the outer boundary of the wellhead protection area. Within Zone 3, existing "high risk" and "medium risk" potential contaminant sources will be targeted to receive increased regulatory attention and technical assistance, with an emphasis on pollution prevention and risk reduction management.

Buffer zone: an area up-gradient from Zone 3, potentially extending to include the entire zone of contribution. The buffer zone may also identify additional non-contiguous critical aquifer recharge areas[2] requiring protection from contamination.

[2] As defined under section 36.70A.170 of the Growth Management Act.

Figure 1. Local Wellhead Protection Program Implementation Flow Chart



Role / Responsibilities

The Washington State Department of Health is responsible for overseeing the State Wellhead Protection Program. Other state agencies, such as the Department of Ecology and the Department of Agriculture, are integrating wellhead protection measures into new and existing programs.

Local governments with zoning authority are responsible for land use planning and zoning. Local agencies, such as the departments of community development and local health departments, can play a major role in helping purveyors protect their community's drinking water supply, and in coordinating wellhead protection measures for multiple purveyors within a given area. Purveyors are responsible for the delineation and inventory of wellhead protection areas.

Wellhead Protection Area Inventory and Management

An inventory should be conducted following delineation of the wellhead protection area boundaries. The purpose of the inventory is to locate all potential sources of ground water contamination within the wellhead protection area. An inventory of potential contamination sources is essential – without identifying potential threats, pollution prevention and risk reduction steps cannot be taken.

Many public water systems in Washington State are owned or operated by non-governmental entities. In addition, a large number of wellhead protection areas will include areas outside the jurisdiction of the public water system owner. To help resolve multi-jurisdictional issues, DOH promotes and encourages establishment of a local wellhead protection committee. Existing groups in the community such as a Ground Water Advisory Committee[3] or a Water Utility Coordinating Committee may serve as the nucleus of a local wellhead protection committee. Coordinating efforts may provide significant cost savings when delineating and inventorying.

Within one (1) year of the definition of the wellhead protection area boundaries, an initial inventory should be completed for the wellhead protection area. Land use practices change over time, therefore inventory data should be updated no less often than every two (2) years.

Contingency Planning

WAC 246-290-135 (4)(c)(vi) establishes the requirement that, as part of a wellhead protection program, public water systems are to develop a contingency plan to ensure consumers have an adequate supply of potable water in the event that contamination results in the temporary or permanent loss of the principle source of supply (major well(s) or wellfield).

Contingency plans should be established within one (1) year of completing the wellhead protection area delineation(s).

[3] Committee responsible for the development and implementation of local Ground Water Management Program.

Spill / Incident Planning

In conjunction with the contingency plan, the water system must work with local emergency responders (e.g. police, fire departments), the Department of Ecology's Spill Operations Section, the Department of Community Trade and Economic Development's Emergency Management Program and any local emergency planning committee to evaluate whether changes in incident/spill response measures are needed to better protect ground water quality within wellhead protection areas.

Coordination with local emergency responders should be initiated within one (1) year of completing the wellhead protection area delineation.

Relationship to Current Planning Requirements

All Group A public water systems are required to prepare either a Water System Plan pursuant to WAC 246-290-100 or a Small Water System Management Program document under WAC 246-290-410. Wellhead protection plans are a required component of both documents.

Appropriate elements of a local wellhead protection program must be documented and included in either the Water System Plan or the Small Water System Management Program document. The Water System Plan is reviewed on a 6-year cycle by DOH. Systems whose plans are reviewed within 5 years of July of 1994 must include the appropriate pieces of the Wellhead Protection Program as indicated by the timeline shown in Figure 1. Systems submitting a Water System Plan after the five-year implementation schedule will be required to document a completed wellhead protection program.

Small Water System Management Program documents are currently reviewed on an "as needed" basis. Appropriate components of the wellhead protection program must be included for systems whose plans are reviewed within five (5) years of July of 1994. All systems submitting a Small Water System Management Program document after the five-year implementation schedule will be required to document a completed wellhead protection program.

New Wells used for Public Water Systems

A delineation and initial inventory are required prior to new source approval (WAC 246-290-130). This is to ensure that existing potential contaminant sources can be identified and evaluated before a well is approved for a public water system. All other elements of the Wellhead Protection Program and the Department of Ecology's Well Construction standards will also apply. Delineations for new sources may be done using a Calculated Fixed Radius method.

1. Introduction

Ground water is the source of drinking water for an estimated 65% of Washington's citizens. In some counties, dependency on ground water supplies approaches 100%. We now know that ground water used for drinking water supplies is often vulnerable to contamination. Most public water supply wells are located in or around the communities using them as a drinking water source. Therefore, preventative measures must be taken to minimize the possibility that land uses will contaminate the ground water utilized by public water systems.[4]

The proposed Wellhead Protection Program presented here was developed by DOH, with valuable input from a variety of sources. First and foremost are the members of the Wellhead Protection Policy Advisory Committee and the Wellhead Protection Technical Advisory Committee. Additional input was received during more than 35 public presentations and workshops conducted by DOH during the period July 1991 through December 1992. For more details, please reference Chapter 12 of this document.

Section 1428 of the 1986 Amendments to the federal Safe Drinking Water Act mandates each state develop a wellhead protection program (Appendix A-1). In Washington State, the Governor designated the State Department of Health (DOH) as lead agency for wellhead protection program development and administration. The Safe Drinking Water Act requires that all federally defined public water systems (Group A systems[5]) using ground water as their source implement a wellhead protection program. In July of 1994, the Washington Administrative Code addressing requirement for Group A public water systems (WAC 246-290) was modified to include mandatory wellhead protection measures for all Group A public water systems in the state using wells or springs (excluding systems using purchased sources or interties) as their source of supply (Appendix A-2). In Washington State, local wellhead protection programs shall, at a minimum, include the following elements:

- A complete susceptibility assessment;
- A delineated wellhead protection area for each well, wellfield, or spring;
- An inventory within the wellhead protection area of all potential sources of contamination that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring, or wellfield;
- Documentation that delineation and inventory findings are distributed to required entities;
- Contingency plans for providing alternate sources of drinking water in the event that contamination does occur; and
- Coordination with local emergency responders for appropriate spill / incident response measures.

[4] **Public Water System** (PWS) – is generally defined in Washington State as any system, excluding systems serving only one single-family residence, providing piped water for human consumption. For a more comprehensive definition, please reference WAC 246-290-020.

[5] DOH uses the term "**Group A**" to designate those public water systems which meet the federal definition of a public water system. This includes all public water systems which serve 25 or more persons or 15 or more connections. Please reference WAC 246-290-020 for more details.

The intent of the wellhead protection program is to be pro-active and prevent contamination of ground water used for drinking water. The objective of wellhead protection is to protect the health of people using ground water supplies of drinking water. This will be accomplished by providing management zones around public wells or wellfields to detect and manage potential sources of ground water contamination.

Pollution prevention is the State's preferred approach to ground water protection. In conjunction with other federal, state, and local ground water protection programs such as the Sole Source Aquifer Designation, Ground Water Management Area Program, Aquifer Protection Area Designation, Critical Aquifer Recharge Area management under the Growth Management Act, and the state's point source and nonpoint source pollution control programs, Washington's Wellhead Protection Program provides a safeguard for ground water used by public water systems. This integrated approach, emphasizing intra- and interagency coordination among multiple levels of government, is the best method for protecting public drinking water supplies.

Washington's Wellhead Protection Program follows statutory requirements found under Section 1428 of the 1986 Federal Safe Drinking Water Act (SDWA) Amendments. Wellhead protection assists local communities in protecting their ground water based drinking water supplies. A component of the Wellhead Protection Program is the delineation of wellhead protection areas. A wellhead protection area is defined as the surface and subsurface area surrounding a well or wellfield that supplies a public water supply through which contaminants are likely to pass and eventually reach the water well(s). In simpler terms, it is the area managed by a community to protect ground water based public drinking water supplies.

Within wellhead protection areas, potential contaminant sources are identified and managed to eliminate or reduce their risk of contaminating public water supplies. Washington's Wellhead Protection Program advocates a progressive management concept. Education and use of Best Management Practices (BMPs) are important measures which may reduce or eliminate the need for restrictive regulatory protection plans. Local land use protection or design standards may be necessary to protect the drinking water supply.

DOH serves as the contact point for individuals, organization, and municipalities seeking information on Washington's Wellhead Protection Program. Questions on wellhead protection should be directed to:

Wellhead Protection Program
Washington Department of Health
P.O. Box 47822
Olympia, WA 98504-7822
(360) 236-3146 / dgl0303@doh.wa.gov

Costs of Contamination

A primary motivation for implementing a local wellhead protection program is that the financial impact of a contaminated public water supply can be quite high. Experience shows that it is considerably more cost effective to implement a pro-active pollution prevention program to guard against ground water contamination rather than pay for an alternate drinking water supply or initiate ground water remediation efforts.

Direct costs associated with well contamination include:

- Administrative costs of responding to contamination,
- Loss of developed wellfield,
- Purchase of water while locating an alternate supply,
- Hydrogeologic studies to locate alternate source water,
- Development of a new water source-*if there is unallocated ground water available,*
- Application costs for obtaining new water rights,
- Engineering, construction and equipment costs of well replacement (with large municipal wells valued between $100,000-800,000 each),
- Treatment of contaminated ground water-if possible,
- Investigation/remediation costs,
- Public information and education costs,
- Legal proceedings against responsible party, if identified,
- Unanticipated acceleration of amortization costs, and
- Increased monitoring requirements.

Indirect costs associated with ground water contamination affecting a public water supply include:

- Loss of (peak) capacity,
- Reduced consumer confidence,
- Lost opportunity costs,
- Potentially increased health risks,
- Potential reduction in development opportunities, and
- Potentially lower property values and tax base.

Once water well is contaminated, a facility's operations come under increased public scrutiny. Many investors will not locate in an area without conducting an environmental audit. The perception of contaminated water may cause potential developers to look elsewhere. Property values may decline, reducing the tax base.

Many communities are recognizing that their water supplies are vulnerable to contamination. This awareness, coupled with increased information on both the direct and indirect costs associated with wellfield contamination, is a key force driving implementation of local wellhead protection programs.

Wellhead Protection and Monitoring Requirements under Phase II and Phase V

Under the 1986 amendments to the SDWA, Congress expanded the contaminant monitoring requirements for many public water systems. If no monitoring waivers are granted, Group A systems are required to analyze for over 80 different Volatile Organic Compounds (VOCs) and Synthetic Organic Compounds (SOCs). DOH is able to reduce monitoring requirements for systems determined to be at relatively low risks of exposure.

Monitoring requirements can incorporate both site variability in hydrogeologic susceptibility to contamination, and the current and past history of contaminant loading when determining sampling frequency. These two factors, hydrogeologic susceptibility and contaminant loading, combine to indicate a public water supply's vulnerability (potential for contamination). Based on a public water supply's vulnerability assessment and on-going contaminant control measures through effective wellhead protection efforts, it is expected that DOH will establish a reduced monitoring program (with a subsequent substantial reduction in monitoring costs) for many ground water based public water systems.

2. Roles and Responsibilities

Overview

Ground water protection in Washington occurs through a coordinated effort between a variety of local, state, and federal agencies. A detailed overview of Washington's current ground water protection programs and activities can be found in the EPA document: *Profile of Ground Water Quality Protection 1992-State of Washington* (see Bibliography).

Public water system purveyors have the primary responsibility for developing and implementing local wellhead protection programs. Due to purveyors' often limited jurisdictional and/or regulatory authorities, it is essential that they work with many other agencies and programs, at all levels of government, to ensure effective implementation. Numerous local, state, and federal agencies are responsible for providing technical assistance and outreach and have regulatory responsibilities for many of the potential sources of ground water contamination identified during the inventory process.

Public Water Systems

All Group A public water systems are currently required to prepare either a Water System Plan pursuant to WAC 246-290-100 or a Small Water System Management Program under WAC 246-290-410. Modifications to WAC 246-290 were adopted in May of 1994 that require wellhead protection plans to be included in both of these planning documents. Local wellhead protection programs are to be developed and implemented by all Group A system purveyors using ground water or springs as source water.

The wellhead protection program portion of a water system's planning document should contain, at a minimum, the following elements:

1. A completed susceptibility assessment;

2. Wellhead protection areas delineated for each well, wellfield, or spring with the one, five and ten-year time of travel boundaries marked, or boundaries established using alternate criteria approved by the department in those settings where ground water time of travel is not a reasonable delineation criteria;

3. A list of known and potential ground water contaminant sources located within the defined WHPA(s) that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring, or wellfield. This list shall be updated every two years. A description of how the inventory of potential contaminant sources was done and how it will be updated should be included[6];

4. Documentation of purveyor's notification to all owners / operators of known and potential sources of ground water contamination within the WHPA boundaries;

[6] A DOH publication "*Inventory of Potential Contaminant Sources in Washington's Wellhead Protection Areas*" is available to assist purveyors in conducting inventories.

5. Documentation of purveyor's notification to regulatory agencies and local governments of the boundaries of the WHPA(s) and the finding of the WHPA inventory;

6. A contingency plan for providing an adequate supply of potable water in the event that contamination results in the temporary or permanent loss of the principal source of supply; and

7. Documentation of coordination with local emergency responders (including police, fire and health departments), including notification of WHPA boundaries, results of susceptibility assessment, inventory findings, and contingency plan.

Public water systems owned and operated by local jurisdictions have clear authorities to protect ground water through zoning decisions, building and operating standards, land use controls, public health ordinances, and other measures. Other public water systems, however, have no land use authorities. These systems will need to work cooperatively with the local jurisdiction(s) and regulatory agencies to ensure adequate protection of their wells.

Coordinating efforts between public water systems may provide significant cost savings when delineating and inventorying. An example of such a savings might be during the delineation process. Where there are multiple public water systems in an area required to delineate using analytical or other site-specific methods, it may be substantially less expensive, per system, if several systems contract jointly for delineation modeling.

A checklist of required wellhead protection elements for water system planning documents, a generic "Scope of Work" for a local wellhead protection program, and sample notification letters are included as Appendices B-1, B-2 and B-3.

Local Governments

The majority of the responsibility for implementing wellhead protection lies at the local level. In Washington, land use planning occurs at the local government level. Purveyors of public water systems and the communities dependent on their water supplies have a strong interest in protecting the drinking water resource. This may be accomplished by strong educational programs, use of Best Management Practices and other non-regulatory approaches.

In some settings, adopting zoning ordinances or codes which limit activities around the water supply, setting design or operating standards for facilities located within the wellhead protection area, or other regulatory approaches may be needed. Local officials with land use authorities will select and implement the necessary steps to protect the community's water supply. Local departments of community development or similar local planning agencies have a key role in assuring that wellhead protection programs are integrated in the overall planning occurring within the community. An excellent summary of common measures used in local wellhead programs can be found in the US EPA document: *Wellhead Protection: Tools for Local Government.* Copies can be obtained from EPA Region X's Ground Water Section (Appendix C).

Wellhead protection areas can be identified as a type of critical aquifer recharge area under the Growth Management Act (GMA). A local wellhead protection program can serve as a mechanism to protect critical aquifer recharge areas. The converse is also true: declaration of a wellhead protection area as a critical aquifer recharge area subject to local regulations and

policies to protect such areas is a useful component of a local wellhead protection program. An interjurisdictional planning mechanism is provided through the GMA to work on the protection of critical areas[7].

Local Wellhead Protection Committees

Due to the fact that many wellhead protection areas will lie, at least in part, outside of the jurisdiction of the purveyor, interjurisdictional cooperation is essential for effective wellhead protection. To help resolve multi-jurisdictional issues, a Local Wellhead Protection Committee should be established very early in the process. Representatives from all affected jurisdictions, regulatory agencies, and other constituencies (private sector, citizen groups, media) should be participants. In many settings, a local government agency is most appropriate as the designated lead agency of the committee. Existing groups in the community such as a Ground Water Advisory Committee or a Water Utility Coordinating Committee may serve as the nucleus of a local wellhead protection committee. In areas with multiple small to medium sized public water systems, a high degree of coordination is essential. Coordinators of local government programs such as watershed management and growth management need to be involved in local wellhead protection implementation efforts beginning in the very early stages. Coordinating efforts may provide significant cost savings when delineating and inventorying.

Local wellhead protection committees' roles may vary depending on the county they are located in. In some counties, the local wellhead protection committee may play a major role in almost every aspect of wellhead protection-from coordinating delineation and inventory efforts to prioritizing potential contaminant sources and developing management approaches. In other areas, it may be appropriate for the committee to focus primarily upon development of protective strategies, leaving the delineation and inventory up to individual purveyors.

Local/County Health Departments

Local health departments (LHDs) have authority and responsibility for protection of public health. The majority of LHDs maintain records on approval of individual septic systems. Most LHDs have assumed some level of responsibility for administering a drinking water program, with primary focus on individual and Group B public water supplies (less than 15 connections or fewer than 25 persons served). The level of LHD involvement in administering the State drinking Water Program is delineated in a joint operating agreement negotiated between DOH and each LHD.

In some counties, the LHD may agree to play a lead role in helping to implement wellhead protection. LHD wellhead protection activities may include assisting in the inventory process, acting as an advocate to the local political jurisdictions, or providing technical assistance to purveyors of small public water systems. Two examples of LHDs taking a leading role in helping implement wellhead protection are: 1) the Thurston County Health Department is exploring how LHDs can help privately owned public water systems implement effective local wellhead protection programs, and 2) the Tacoma-Pierce County Health Department, which is helping to implement a regional wellhead protection program by providing technical assistance to small public water systems.

[7] For more details, contact the Washington State Department of Community Trade and Economic Development's Growth Management Section (Appendix C).

In several counties, the local health department is the lead agency for developing a Ground Water Management Area program. Integrating wellhead protection planning into an overall ground water management program is one of the best ways to ensure that multi-jurisdictional coordination will occur during implementation.

State Agencies

A variety of state agencies have ground water protection responsibilities and authorities. Wellhead protection does not transfer authorities for potential contaminant source control away from existing agencies. Information developed during wellhead protection area inventories will be used by agencies with existing authorities in setting priorities for technical assistance outreach, field inspections, enforcement actions and other activities.

Agency addresses and program contacts are listed in Appendix C.

Interagency Ground Water Committee

During the past several years it has been recognized that ground water protection would be more effective if implementation efforts were better coordinated between programs, agencies and various levels of government (federal, state, local, tribal). There is further recognition that there are discrepancies between programs, possible gaps in control mechanisms, and some duplicative use of limited ground water protection resources.

On January 21, 1992, an initial state interagency ground water coordinating group meeting was held, partially in response to this lack of coordination. Subsequent to the initial meeting, the group formalized its existence, established a regular meeting schedule, and developed a set of goals and objectives. The Interagency Ground Water Committee (IGWC) consists of participating agencies including state and federal agencies, local governments and tribes (Appendix D). A primary goal of the IGWC is to provide a forum at which ground water related issues, programs or activities with interjurisdictional implications can be examined.

The Interagency Ground Water Committee will serve as a primary mechanism for addressing cross-program and cross-agency issues related to wellhead protection implementation.

Washington State Department of Health

The Department of Health (DOH) is responsible for protecting public health by assuring a safe and reliable drinking water supply. DOH implements drinking water protection through monitoring supplies, pollution prevention efforts, and a cooperative relationship with water utilities and local health jurisdictions. DOH has primary responsibility for implementation of the federal Wellhead Protection Program requirements and other components of the federal Safe Drinking Water Act (SDWA), and establishes the monitoring and planning requirements for public water systems.

In Washington State, with some exceptions, a public water system is defined as any system, excluding a system serving only one single-family residence, providing piped water for human

consumption. Group A public water systems are those systems which meet the federal definition of a public water supply (15 or more connections, or 25 or more persons served). A more complete definition of public water systems can be found in WAC 246-290-020.

DOH's Division of Drinking Water is responsible for oversight of the engineering and operational function of public water systems. The division maintains an inventory of public water supply wells and their legal locations. Operational reports containing use and drawdown information are submitted to DOH. The division has access to water quality monitoring data, engineering pump tests and evaluations of the area surrounding well sites through preliminary engineering reports submitted as part of the permit process.

Both Water System Plans and Small Water System Management Program documents are reviewed by DOH staff based on criteria established in WAC 246-290-100 and WAC 246-290-410.

The state Wellhead Protection Office is located in the Water System Planning Section of the Division of Drinking Water under Environmental Health Programs. DOH's Wellhead Protection Office functions in an administrative role in the Wellhead Protection Program—coordinating development of the program, working with appropriate agencies to ensure technical soundness, organizing public meetings and citizen participation efforts, acting as a central repository for information on source identification and control, developing technical assistance documents, and conducting grant administration activities as needed. The Wellhead Protection Office serves as the principal contact for any entity seeking general information on wellhead protection or the wellhead protection program within Washington State. Wellhead protection questions which are water system-specific should be directed to the regional planner at the appropriate DOH Division of Drinking Water Regional Office. (Appendix C)

DOH has been working with the Department of Ecology's Solid Waste Services Program, the Department of Agriculture and others to identify pollution prevention/risk reduction technical assistance information available for potential contaminant sources located within wellhead protection areas. Mechanisms are in place to expedite the transfer of this information to the potential contaminant sources. DOH is also working with a variety of agencies to identify types or classes of potential contaminant sources which lack pollution prevention/risk reduction technical assistance so the need can be noted and addressed as rapidly as possible.

One of DOH's primary roles is to serve as lead agency for wellhead protection implementation. As lead, DOH coordinates and promotes pollution control and prevention measures within wellhead protection areas. Coordination efforts include hosting interagency meetings and conducting workshops on the Wellhead Protection Program, helping develop interagency agreements when deemed appropriate, and actively participating in the Interagency Ground Water Committee.

DOH also offers technical assistance for such tasks as evaluating the potential for ground water contamination from facilities/activities within a designated wellhead protection area, and developing management and contingency plans. In addition, DOH serves as a point of contact for information on actions which can be taken at the local level to minimize the probability of contamination.

Washington State Department of Ecology

The Department of Ecology (Ecology) is the primary environmental protection agency in Washington. As a result, several of Ecology's programs have significant roles in implementing Washington's Wellhead Protection Program. These include the Water Quality Program; the Water Resources Program; the Toxics Cleanup Program; the Solid Waste Services Program; and the Hazardous Waste and Toxics Reduction Program. Ecology is an active participant in the Interagency Ground Water Committee.

The **Water Quality Program** oversees several programs which relate to wellhead protection and the protection of ground water quality, including the Underground Injection Control (UIC) program and administering the state Ground Water Quality Standards. Wellhead protection areas located in susceptible hydrogeologic settings may be classified as "Special Protection Areas" as defined by the Ground Water Quality Standards. This enables Ecology to establish additional discharge or monitoring requirements on permitted facilities discharging to the ground water. Please reference Chapter 173-200 WAC, Water Quality Standards for Ground Waters for more details on Special Protection Area designation.

The Water Quality Program is also in the lead role for management and control of both point and nonpoint sources of pollution. As potential contaminant sources are identified within delineated wellhead protection areas, DOH will work with the Water Quality Program of Ecology and other appropriate agencies and programs to provide technical assistance to the identified party(s) in order to minimize or eliminate the risk of ground water contamination.

Water quality financial assistance, including the state Centennial Clean Water Fund (CCWF) and Wastewater State Revolving Fund (SRF), is administered through the Water Quality Program. The CCWF has annually provided several million dollars in the form of competitive grants to local governments for ground water quality protection efforts. This fund can, and has been, used to help implement local wellhead protection programs (**Table 1**). The Wastewater State Revolving Fund is a loan program to local governments for implementing water pollution control projects, both facilities and activities. It too has been used as a funding mechanism for local wellhead programs.

The **Water Resources Program** has joint responsibility for the Ground Water Management Area Program (GWMA) along with the WQFAP. The GWMA Program is an important complement to the state's Wellhead Protection Program. A GWMA is established to protect ground water quality and quantity, and manage the resource over a large area and for all beneficial uses (not just drinking water). Wellhead protection can be an important component of a GWMA; serving as an initial starting point for implementation efforts. For more details on the GWMA program, contact Ecology's Water Resources Program (Appendix C).

The Water Resources Program is also responsible for ground water right allocations, permitting well drillers, performing hydrologic studies on each ground water basin, licensing of ground water/observation and monitoring well drillers, enforcing minimum well constriction standards and other programs relating to ground water management and protection.

Table 1. Selected Wellhead Protection Programs Funded by the Centennial Clean Water Fund

Recipient	State Grant Award	Local Match	Total Project Cost
Benton Franklin Regional Government	75,000	25,000	100,000
City of Blaine	125,975	125,975	251,950
City of Everson	13,000	13,000	26,000
City of Kent	82,565	82,565	165,130
City of Lacey	100,000	100,000	200,000
City of Moses Lake	199,000	199,000	398,000
City of Newport	30,000	30,000	60,000
City of Olympia	212,000	212,000	424,000
City of Redmond	52,500	52,500	105,000
City of Spokane	246,000	246,000	492,000
City of Sumas	61,819	20,586	82,405
City of Tacoma	224,000	224,000	448,000
City of Tacoma/Pierce County	47,000	47,000	94,000
City of Tumwater	170,534	170,534	341,068
Clark County	185,030	185,030	370,060
Clark Public Utilities	235,000	235,000	470,000
Covington Water District	71,925	71,925	143,850
Douglas County	150,600	150,600	301,200
Intergovernmental Resource Center, Clark County	207,000	207,000	414,000
Quileute Tribe	21,084	7,021	28,105
Sammamish Plateau Water & Sewer District, Issaquah Valley	168,500	168,500	337,000
Thurston County	349,000	349,000	698,000
Tulalip Tribes of Washington	15,675	15,675	31,350
Walla Walla Planning Department	150,000	150,000	300,000
Total State Contribution	**$3,193,207**	**Total Expenditure**	**$6,281,118**

The Water Resources Program maintains an inventory of wells in the state including public and private water supplies. The inventory contains locational information such as legal descriptions and latitude/longitude. Well construction descriptions and lithologic data are submitted by the well driller and maintained at Ecology's regional offices. This information may be valuable to public water systems as they model their wellhead protection areas or conduct potential source inventories (locating abandoned wells for example).

The **Solid Waste Services Program** offers technical assistance to local governments on waste management and pollution prevention issues. This program also manages the Moderate Risk Waste program-including small quantity generators of hazardous wastes, those that fall below thresholds regulated under the State Dangerous Waste Regulations. A primary objective of wellhead protection is to implement pollution prevention and risk reduction measures within wellhead protection areas. For this reason, the Solid Waste Services Program has a key role in technical assistance outreach efforts as potential sources of ground water contamination are identified.

Two other programs in Ecology are working closely with DOH as the state wellhead protection program evolves. **The Hazardous Waste and Toxics Reduction Program** is responsible for administering the federal Resource Conservation and Recovery Act (RCRA) program and providing pollution prevention assistance to businesses. This program and DOH's Wellhead Protection Office jointly implemented a pollution prevention grant from EPA to target technical assistance to RCRA facilities within wellhead protection areas. **The Spill Operations Section** is working with DOH and the Washington Association of Fire Chiefs to develop a Standard Operating Procedures (SOP) guide for emergency first responders to use when reacting to a chemical spill or potential release within susceptible ground water areas.

Washington State Department of Agriculture

The Washington State Department of Agriculture (WSDA) responsibilities, as they pertain to ground water protection, include: regulating confined animal operations; pesticide registration, usage, storage, and application; and regulation of commercial fertilizer storage, transportation, and use.

WSDA is the state agency with primary authority and responsibility to regulate pesticide and agricultural chemical use. WSDA will work with the Conservation Commission, WSU/Cooperative Extension, Ecology's Water Quality Program, DOH, and other appropriate agencies to develop BMPs for agricultural operations located within wellhead protection areas determined to be potential contaminant sources.

Wellhead protection areas located in susceptible hydrologic settings may be classified as "Special Use Areas". Within a special use area, WSDA can require additional application or monitoring requirements, or restrict the use of certain agricultural chemicals. Reference Chapter 16-228 WAC or contact WSDA for more details (Appendix C).

WSDA is an active participant in the Interagency Ground Water Committee.

Washington State University (WSU) Cooperative Extension

WSU/Cooperative Extension has educational centers in all Washington counties. Area agents provide direct technical assistance and information to community residents on many environmental issues, including water quality. Agents can help develop local wellhead programs and, based on available resources, will have a significant role during program implementation.

Washington State Department of Community Trade and Economic Development

Pursuant to RCW 36.70A.050, 36.70A.060 and 36.70A.170, the Growth Management Act (GMA) requires that local jurisdictions identify and protect critical areas including areas with a critical recharging effect on aquifers used for potable water.

The Department of Community Trade and Economic Development (CTED) is responsible for carrying out the intent of the GMA. Wellhead protection areas are recognized as one type of Critical Aquifer Recharge Area. CTED also oversees the Public Works Trust Fund, a state loan program which can aid local jurisdictions in funding implementation of wellhead protection. CTED's Office of Emergency Management works with local emergency management programs, and is an important resource when developing spill response plans.

CTED is an active participant in the Interagency Ground Water Committee.

Washington State Conservation Commission

The Washington State Conservation Commission (WSCC) gives administrative and program assistance to the statewide network of 48 Conservation Districts. Conservation Districts are legal subdivisions of state government that administer programs to conserve natural resources. Conservation Districts are responsible for helping landowners learn and adopt conservation Best Management Practices (BMPs), including those that reduce or eliminate the leaching of pollutants into ground water supplies. These BMPs are directed at land use practices such as agriculture, urban construction or storm water run-off. BMP development activities are carried out in coordination with other federal, state or local agencies that may exercise regulatory authority over aspects of these land use categories. Conservation Districts promulgate BMPs through education, technical and other voluntary approaches.

The WSCC, in conjunction with Washington's 48 Conservation Districts and the USDA SCS, maintains inventory information on soil conditions and land use patterns across the state. The WSCC will make this data available to help identify potential nonpoint sources of pollution that could impact drinking water wells.

Local conservation districts may identify site-specific activities that have the potential to contaminate ground water, and can participate in development of local wellhead programs. They are responsible for promoting ground water protective BMPs; therefore they will have a significant role during implementation of local wellhead programs.

WSCC is an active participant in the Interagency Ground Water Committee.

Federal Agencies

Although the Wellhead Protection Program is a state program, there is a role for federal agencies. The **U.S. Environmental Protection Agency (EPA)** is the lead federal agency for wellhead protection. EPA reviews and approves state wellhead protection programs. EPA provides federal funding for the state Wellhead Protection Program Office, develops technical assistance documents, hosts workshops, and has provided wellhead protection demonstration grant monies to local governments. In addition, if a federal facility is located within a delineated wellhead protection area, EPA can be a liaison between the local program and the federal facility, ensuring that the federal facility takes the appropriate steps to minimize or prevent ground water contamination.

The **Natural Resources Conservation Service** of the U.S. Department of Agriculture (NRCS) (formerly the Soil Conservation Service-SCS) offers technical assistance for ground water quality protection to landowners located within wellhead protection areas. Also, under the 1990 Federal Farm Bill, the USDA can enroll some agricultural areas located within wellhead protection areas in its Conservation Reserve Program. The NRCS is also an excellent source of technical information concerning water quality protection from agricultural operations.

In Washington State, NRCS employees work on programs in conjunction with local Conservation Districts. They work with District boards and staff to coordinate programs.

The **United States Geological Survey (USGS)** is a research-oriented agency with considerable technical expertise in ground water hydrogeology. USGS has collected detailed information on the geology of various formations and on subsurface hydrologic conditions. The USGS works with communities across the state in modeling hydrogeologic settings. These studies often provide the technical information needed to delineate wellhead protection areas as well as aid in data collection and analysis. Other ground water quality studies done by the USGS may also assist local governments in protecting ground water quality. The USGS has been an active participant in the Technical Advisory Committee, providing technical review of the proposed delineation methods.

Washington's Wellhead Protection Program and Federal Facilities

Under the SDWA Amendments of 1986, any department or agency of the federal government with jurisdiction over any potential source of contaminant within wellhead protection areas is subject to, and must comply with, all requirements of the State's Wellhead Protection Program. This includes the payment of reasonable charges and fees levied in connection with the management or remediation of potential contaminant sources.

DOH will continue to contact all federal agencies with land management responsibilities in the State, educate them on wellhead protection and how it may potentially affect their activities. Department of Defense installations, Department of Interior facilities, and other federal areas with public water systems should have wellhead protection area delineations developed. Federal facilities determined to have control of areas located within a delineated wellhead protection area (from either an adjacent public water supply or from their own public water supply) will be expected to comply with all applicable rules and regulations. Federal facilities will be

encouraged to develop their own rules and regulations above and beyond the minimum legal requirements to protect Washington's ground water and drinking water resources.

Washington's Wellhead Protection Program and Tribal Areas

DOH will assist Indian tribes located within Washington's boundaries by providing technical assistance upon request. Tribes may be eligible for state water quality grants and loans. DOH will work with tribes to address interjurisdictional questions when wellhead protection areas cross reservation boundaries. Both EPA and the Indian Health Service offer technical and financial assistance to tribes for wellhead protection implementation efforts.

3. Implementation

Legal Basis for Requirements

Public water systems are the only entities with direct legal requirements under the state Wellhead Protection Program. All new and existing Group A systems using wells or springs as their source of supply (excluding systems using purchased sources, or interties) are required to develop local wellhead protection programs. While Group B systems (fewer than 15 connections, and less than 25 persons served) have elements of wellhead protection incorporated into their new source approval requirements, the state Wellhead Protection Program applies only to Group A systems.

The state Wellhead Protection Program is a requirement for Group A public water systems. The Washington Administrative Code (WAC) pertaining to Drinking Water Regulations for Group A systems (WAC 246-290) was modified in July of 1994 to explicitly require wellhead protection measures.

The legislative authorities to require wellhead protection planning can be found in the Revised Code of Washington (RCW) Chapters 43.20.050, 70.119A.060, and 70.119A.080.

The State Board of Health has the authority and responsibility to adopt rules necessary to assure safe and reliable public drinking water. These rules establish requirements on such topics as: water quality, reliability, management, planning, emergency response requirements, and reporting requirements.

RCW 70.119A.060 establishes mandates for public water systems including protecting the water sources used for drinking water, assuring the availability of safe and reliable drinking water, and taking whatever investigative action is necessary to assure that a safe and reliable drinking water supply is continuously available to users.

DOH has authority through RCW 70.119A.080 to administer a drinking water program which includes program elements of section 1428 of part C of the federal Safe Drinking Water Act (wellhead protection requirements).

With these legislative directives in place, no revisions to existing RCWs were deemed necessary prior to modification of WAC 246-290.

Implementation Schedule

The timetable for compliance began in July 1994 (**Figure 1**). By July 1995, all ground water based Group A systems are expected to complete a susceptibility assessment (which includes an assessment of the circularity of the zone of contribution). The findings from the assessment and system size determine the minimum acceptable delineation method. For most systems, a calculated fixed radius method may be employed. For more details on minimum delineation requirements, and which systems can use a calculated fixed radius method as delineating method, reference Chapter 4 of this document.

Systems using the Calculated Fixed Radius method are expected to complete the initial delineation, including boundary mapping, by July of 1995. Systems using more sophisticated, site-specific modeling approaches are expected to complete the delineation process by July of 1996.

Concurrent with the delineation process, the public water system should establish a local wellhead protection committee.

An inventory should be conducted following delineation of the wellhead protection area boundaries. The purpose of the inventory is to locate potential sources of ground water contamination within the wellhead protection area that could threaten current and future waters used as the drinking water supply. Within one (1) year of the wellhead protection area boundaries being defined, an initial inventory should be completed for the entire wellhead protection area (within the 10-year time of travel boundary). Land use practices change over time, therefore inventory data is required by WAC to be updated no less than every two (2) years. If the entire wellhead protection area is large, the initial emphasis should be on detecting potential contaminant sources within Zone 1 (the 1 year time of travel), and detecting high risk sources within Zones 2 and 3 (the 5 and 10 year times of travel). The inventory must be expanded to cover all potential contaminant sources within the entire wellhead protection area as rapidly as possible.

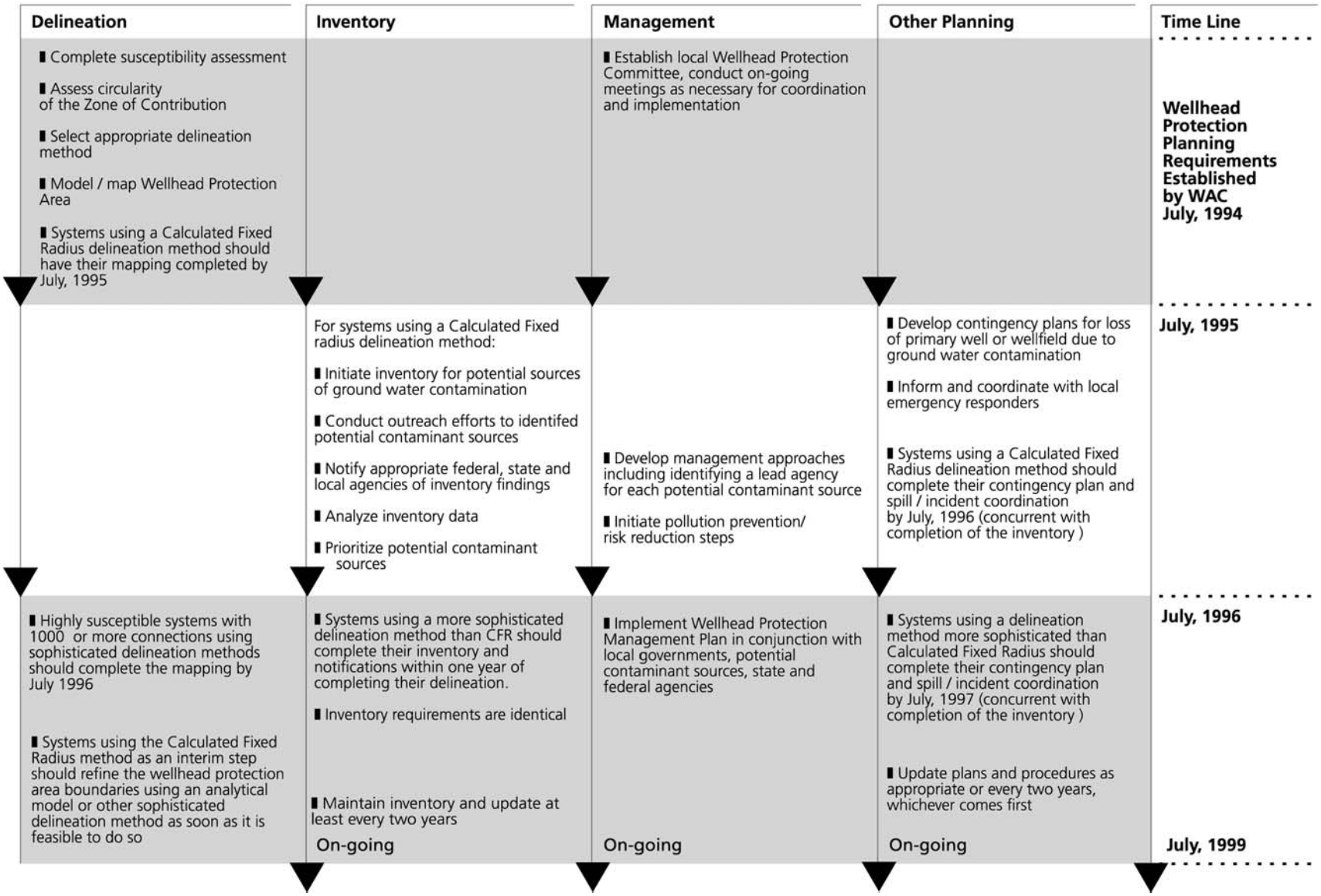
Analyzing the inventory data is essential for a successful wellhead protection program. The identified potential contaminant sources and the agencies and jurisdictions with regulatory responsibilities for the sources should be notified of the source's presence within the wellhead protection area. This should be accomplished in writing within one (1) year of the wellhead protection area boundaries being delineated. Documentation of the required notifications should be maintained. Sample notification letters are provided in Appendix B-3.

The required contingency plans and coordination with emergency responders should also be completed within one (1) year of the wellhead protection area boundaries being delineated. These components of the local wellhead protection program should be kept current and updated every two years at a minimum.

Relationship to Current Planning Requirements

All of the above-mentioned elements of a local wellhead protection program must be documented and included in either the Water System Plan or the Small Water System Management Program document. The Water System Plan is reviewed on a 6-year cycle by DOH. Systems whose plans are submitted prior to July of 1999 must include the appropriate elements of their wellhead

Figure 1. Local Wellhead Protection Program Implementation Flow Chart



protection program in their planning document. Systems submitting a Water System Plan after July of 1999 will be required to have a completed wellhead protection program documented. Small Water System Management Program documents are currently reviewed on an as-needed basis. Appropriate components of the wellhead protection program must be included for systems whose plans are reviewed within five (5) years of the WAC modification. All systems submitting Small Water System Management Program documents after the 5-year implementation schedule will be expected to document a completed wellhead protection program.

Compliance Mechanisms

Systems determined to be out of compliance with the wellhead protection components of either the Water System Plan or the Small Water System Program document may face the following sanctions:

1. Denial of construction documents pursuant to WAC 246-290-100;
2. Determination by DOH that the water system is inadequate possibly resulting in:
   a. Denial of building permits by local governments (RCW 19.27.097);
   b. Denial of subdivisions by local governments (RCW 58.17.060 and 58.17.110);
   c. Denial of home mortgages by lending institutions; and
   d. Receivership action by DOH (RCW 43.70).

Failure to be in compliance with the planning requirements under WAC 246-290, including wellhead protection components, can also be addressed by DOH under WAC 246-290-050 *Enforcement*. When a purveyor of a public water system is out of compliance, DOH may initiate enforcement actions including any one or a combination of the following:

1. Notice of violation instructing or requiring appropriate corrective measures;
2. Compliance schedule for specific actions necessary to achieve compliance status;
3. Departmental order requiring specific actions;
4. Departmental order to stop work and/or refrain from using any public water system or improvements thereto, until all written approvals required by statute or rule are obtained;
5. Imposition of civil penalties for failure to comply with departmental orders may be issued for up to $5000 per day per violation under authority of RCW 70.119A; and
6. Legal action may be taken by the attorney general or local prosecutor. The legal action may be criminal or civil.

Should contamination of the source of supply occur, and subsequent investigation reveals that the purveyor is out of compliance with wellhead protection requirements, water system customers may be in a position to seek civil damages from the purveyor for losses such as decreased property value.

4. Determination of Wellhead Protection Areas

A wellhead protection area is defined as the surface and subsurface area surrounding a well, wellfield or spring that supplies a public water supply through which contaminants are likely to pass and eventually reach the water well(s). In simpler terms, it is the area managed by a community to protect ground water based public drinking water supplies. As the distance from the pumping well is increased, the hypothetical travel time of a particle of water traveling in the aquifer to the well is lengthened.

Establishing the boundaries for each well, wellfield's, or spring's wellhead protection area is an essential element of a local wellhead protection program. Defining (delineating) the wellhead protection area boundaries is the responsibility of the public water system. Technical assistance on wellhead protection area delineation using a Calculated Fixed Radius method is provided in this document, in the Susceptibility Assessment From (Appendix E), and from either the Wellhead Protection Office of DOH or your DOH regional office. For more sophisticated delineation methods, the use of a ground water professional (hydrogeologist, geologist, and/or professional engineer) is often required.

Criteria for setting wellhead protection area boundaries must be selected before delineation can occur. In Washington, wellhead protection areas are defined primarily based on the time of travel rates of ground water. A typical wellhead protection area in Washington will consist of five zones:

- The sanitary control area,
- Three primary zones, based on 1, 5 and 10-year time of travel rates, and
- A buffer zone if necessary.

The three primary zones are determined by estimating the travel paths (based on 1, 5, and 10-year travel times) of a hypothetical particle of water traveling through the aquifer to the pumping well that can be used to identify potential sources of contamination that may (if not controlled) impact the water supply. These travel-time based aquifer management zones can create an "early warning system", providing the public water system with time to respond to a contaminant moving in an aquifer before it arrives at the water supply well. It is important to recognize that contaminants released at the surface will take additional time to move from the surface down to the water-bearing zone. However, the vertical travel time of a contaminant is not considered when calculating the time of travel estimates.

Two considerations are important to note. First, the time of travel calculations are for the rate that water moves through the aquifer. Contaminants may move at significantly different rates than water-either faster or slower depending on the specific contaminant.

Second, because the wellhead protection area delineation calculations ignore the vertical time of travel component (the time a particle of water, or contaminant, takes to move from the surface down to the aquifer) this factor should be considered when developing site-specific wellhead protection area management plans. Similar contaminant sources may need to be managed differently in different hydrogeologic settings. For example, an activity located over a shallow water table aquifer where water moves from the land surface to the aquifer in a matter of hours or days may need to be managed differently than the same activity located in an area where a

particle of water may take months or years to travel from the surface, through a series of aquitards (confining layers) before reaching the aquifer.

Wellhead Protection Area Zones

In Washington, a wellhead protection area is based on established times of travel. Each management zone in the wellhead protection area is an area that corresponds to a certain established time of travel in the aquifer. Thus, each of the zones represent a certain time interval between a particle of water at the zone boundary and its eventual arrival at the well.

Again, it should be noted that these aquifer travel time zones do not consider vertical movement of a water particle or contaminant from the land surface down to the aquifer. The rate of vertical movement or infiltration rate for an aquifer can be highly variable. Within any given aquifer setting, the infiltration rate will depend on topography, soils, geology, and the nature of land surface activities (relative percent impervious surfaces vs. open space). It may vary significantly over a region and even within an individual wellhead protection zone. Because it may be difficult to estimate and predict infiltration rates for all settings the wellhead protection area delineation methods recommended for the State program do not include vertical movement as a part of the base models. This creates a conservative (protective) estimate of travel time. Where infiltration characteristics are known, wellhead protection area zone management plans can and should consider the implication of vertical movement to the aquifer.

The Sanitary Control Area

The first component of a wellhead protection area is the protective area required by WAC 246-290-135 (sanitary control area). This area should already be tightly controlled by the public water supply to minimize any direct contamination at the wellhead. It should be managed to reduce the possibility of surface flows reaching the wellhead and traveling down the casing. All public water systems are encouraged to have a wellhouse or a fenced area around each wellhead. This helps protect individual wells from any direct introduction of contaminants.

Zone 1—the one year horizontal time of travel boundary

Proper management of Zone 1 can protect the drinking water supply from viral, microbial and direct chemical contamination. This zone is defined by the surface area overlying the portion of the aquifer which contributes water to the well within a one-year period. Within Zone 1, potential sources of microbial contamination should be strictly managed to eliminate or reduce the possibility that microbial contamination of the water supply will occur.

The criterion threshold of a one-year time of travel is considered appropriate to protect the wellfield from microbial contamination. Existing literature suggests that bacteria and viruses survive less than one year in ground water, therefore travel times of greater than one year are not necessary. A threshold of less than one year may not provide adequate protection against possible microbial or viral contamination.

The one-year time of travel also defines the area for intensive management to protect the wellhead from direct chemical contamination. Within Zone 1, chemicals capable of

contaminating ground water should not be stored or used, or should be stored and used with sufficient precautions to protect the ground water resource. A serious chemical release within Zone 1 may provide only a very limited time for a purveyor/community to respond aggressively, identify the spill, implement emergency remedial actions and prevent the contamination from reaching the distribution system.

Laboratory confirmation of the contamination, characterization of the contaminant plume, plus development and implementation of an on-the-ground remediation response traditionally takes a minimum of six months. Twelve to twenty-four months is a more typical period for an initial (preliminary) remedial response. Because of these concerns, most management plans for Zone 1 include strong elements for the identification of potential contaminant sources and risk management. For this reason, the one-year time of travel functions as a buffer area and provides response time.

Zone 2—the 5 year horizontal time of travel boundary

The entire area within the 5-year TOT boundary defines Zone 2. This zone should be actively managed for control of potential chemical contaminants. While any significant chemical release within Zone 1 has the potential to contaminate the drinking water supply and render it unusable, the area lying between the 1 and 5-year time of travel boundaries also needs to be carefully managed to protect future water supplies.

The primary difference between potential contaminant sources in Zones 1 and 2 is that release in Zone 2 provides more time for response (less of an acute crisis situation). All potential contaminant sources should be identified and controlled, with an emphasis on pollution prevention and risk reduction management. Both the 1-year and the 5-year zones are used by many state and local agencies as a prioritizing tool for directing technical assistance, outreach programs, and for targeting inspections and enforcement actions.

Zone 3—the 10 year horizontal time of travel boundary

The outer border of Zone 3, the area within the 10-year time of travel boundary, determines the boundary of the wellhead protection area. Within Zone 3, an inventory for potential contaminant sources should be conducted. High-risk operations and facilities should be identified, and steps taken to reduce contaminant loading. A primary purpose of Zone 3 is to encourage decision makers and planners to recognize the long-term source of the drinking water supplying community water systems. This allows the community to plan and site future high risk and medium risk sources of ground water contamination outside wellhead protection areas. Zone 3 also serves as an educational tool for industry, the general public, and others to understand the source of their drinking water and the significance of their actions upgradient of drinking water wells.

Buffer Zone

The buffer zone is an area upgradient of Zone 3. It can extend to include the entire zone of contribution or may focus on selected areas of concern such as recharge areas or locations where the aquifer may be exposed at the surface. The buffer zone can be used to provide an area of

added protection for the wellhead protection area. This zone helps compensate for errors when calculating the wellhead protection area boundaries, and provides information useful for long term planning.

A primary goal of the buffer zone is to provide information to planners on potential contaminant sources outside Zone 3 which have the potential for releasing contaminants into the wellhead protection area. Analysis may show the need for contingency plans to respond to uncontrolled surface discharges that may travel overland to enter a stream located in or adjacent to the wellhead protection area. It may also identify other non-contiguous critical aquifer recharge areas requiring protection.

A Review of Selected Wellhead Protection Area Delineation Methods

Four general delineation methods were selected from those evaluated by the Wellhead Protection Technical Advisory Committee. They are:

- Calculated Fixed Radius
- Analytical Models
- Hydrogeologic Mapping
- Numerical Flow/Transport Models

In general, there is an increase in complexity and cost from the top to the bottom of the list. Along with increasing cost and complexity, there is generally an increase in reliability. Once the boundaries of the WHPA are calculated, they are required to be displayed on a map of suitable scale.

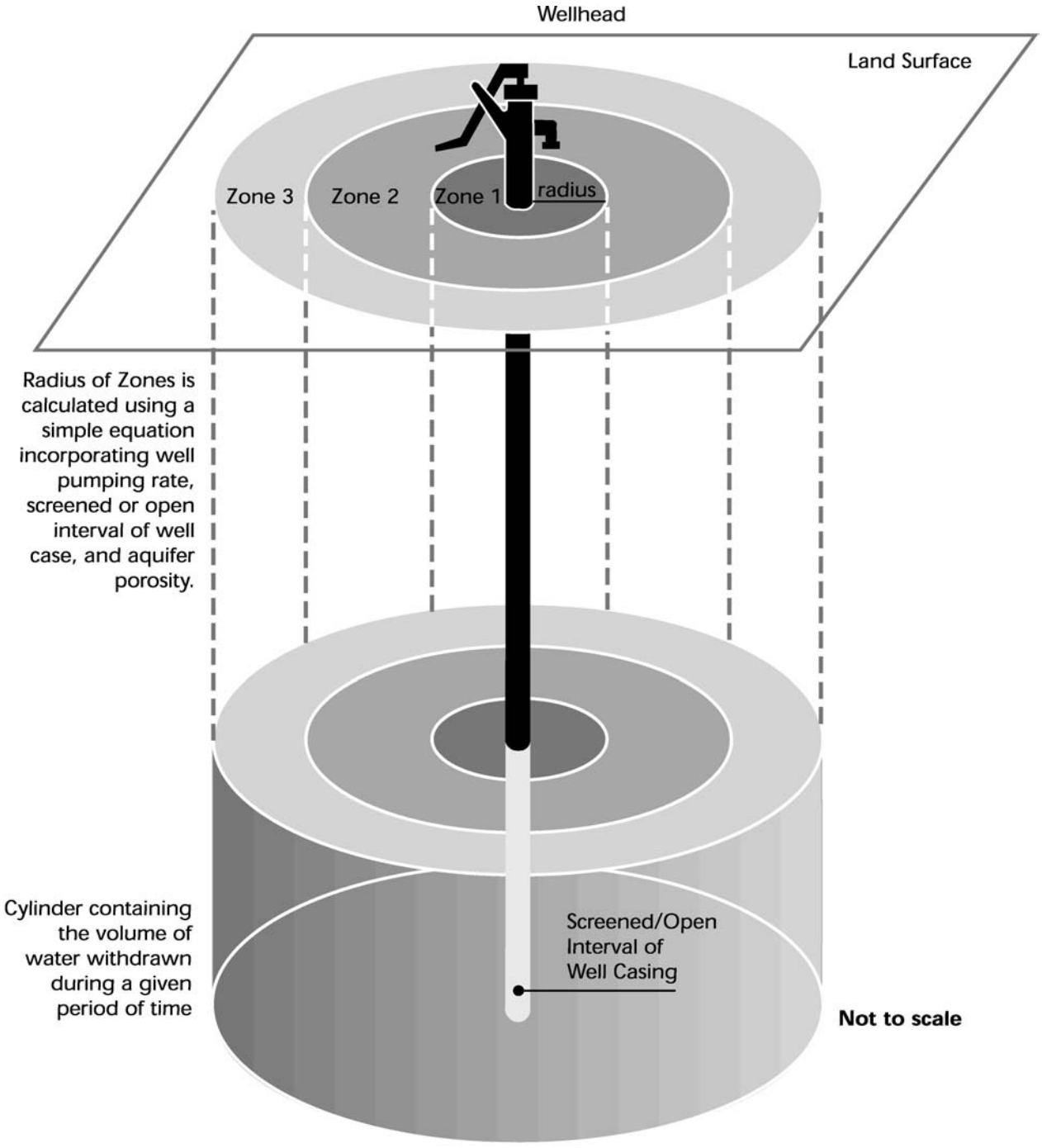
It is critical to conduct a susceptibility assessment of the site prior to selecting a delineation method so an appropriate delineation method can be selected. Not all methods are suitable for all settings. A brief description of each of these methods is presented below.

Calculated Fixed Radius

The Calculated Fixed Radius method draws a circular protection area for a specified time of travel threshold. A simple volumetric flow equation is used to calculate the radius (**Figure 2**). Data required are 1) well pumping rate, 2) porosity of aquifer and 3) open or screened interval of well. If a site-specific estimate of aquifer porosity is lacking, a generalized value of 0.22 may be substituted. If the actual screened interval is unknown, or if the well is constructed with an open interval at its base, a value of 10 feet should be used.

This delineation method is easy to apply and relatively inexpensive; it requires a minimum level of technical expertise. Because of its simplicity, it can be used as a delineation method for moderate and small systems. It should be used by many systems as a first cut method for identifying immediate threats to the water quality. The calculated fixed radius method is part of the basic Washington state susceptibility assessment. A major drawback of this model is that rarely does ground water behave as simply as this model predicts. Please reference Appendix E to the Susceptibility Assessment form (Primary Appendix E) for calculated fixed radius solutions for selected well settings.

Figure 2. Illustration of a Calculated Fixed Radius Model



$$r = \sqrt{\frac{Q\,t}{\pi\,n\,H}}$$

Where:
Q = Pumping Rate of Well (cubic feet per year)
n = Aquifer Porosity = 0.22
H = Open Interval or Length of Well Screen
t = Travel Time to Well (1, 5, 10 years)

Analytical Methods

Analytical methods include simple mathematical calculations and graphical methods to delineate wellhead zones of contribution or simple analytical solution based computerized ground water flow models (**Figure 3**). While they require more skill and data (including hydraulic gradient, hydraulic conductivity, saturated thickness, and hydrogeologic divides) than the calculated fixed radius method, analytical models use equations that are generally easily understood by hydrogeologists and civil engineers.

In many cases, a simple analytical model (such as EPA's WHPA Code[8]), may provide a good approximation of the time of travel boundaries. However, in settings with significant aquifer boundaries and non-uniform hydrogeologic characteristics, more sophisticated methods such as detailed hydrogeologic mapping or numerical modeling may be warranted.

Hydrogeologic Mapping Methods

Hydrogeologic mapping methods are loosely defined by EPA as geologic, geophysical, and dye-tracing methods that can be used to define zones of contribution. In Washington, where hydrogeologic and geologic information is often either regional in scope or non-existent, hydrogeologic mapping is often required to characterize aquifer properties, ground water flow directions, and aquifer boundaries as a prelude to analytical numerical modeling.

Hydrogeologic mapping methods can be useful where hydrogeologic conditions preclude application of simple analytical models. Examples of settings where geologic features exert strong control over ground water flow direction and rates are fractured rock settings, karst, small valley fill deposits, and irregular river or barrier boundaries. Data required include geologic maps, aquifer water level mapping, pump test data, hydrogeologic reports, and well reports.

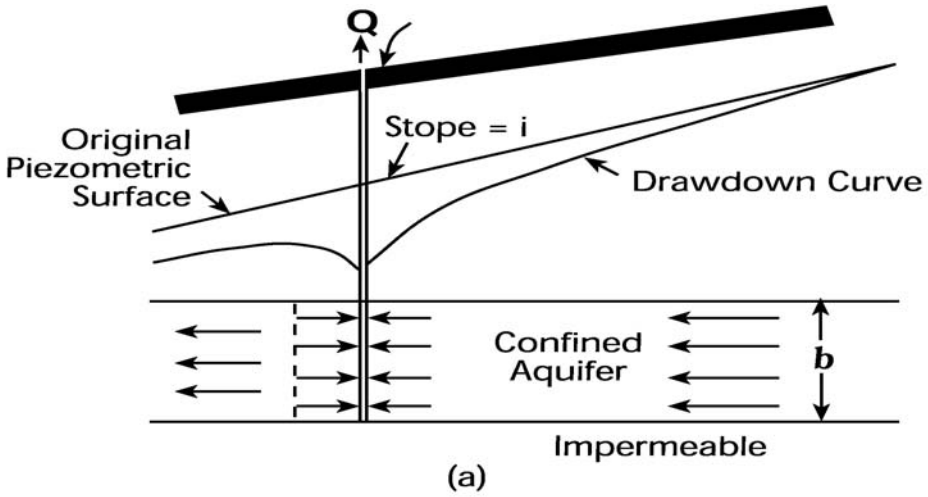
These methods require specialized expertise in geologic and geomorphic mapping, plus significant judgment on what constitutes likely flow boundaries.

Numerical Flow/Transport Models

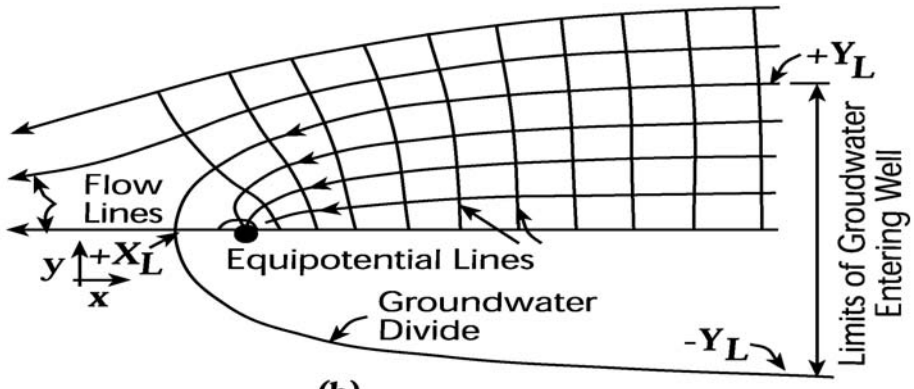
Wellhead protection areas can be delineated using computer models that approximate ground water flow and/or solute transport equations numerically. These models are generally recognized as technically superior means to delineate wellhead zones of contribution, if sufficient data can be assembled. Models are generally grouped as two- and three-dimensional. Data requirements are similar to hydrogeologic mapping and analytical models. However, numerical models are able to incorporate much more of this information. A comparison of wellhead protection area boundaries delineated using the calculated fixed radius method, an analytical model, and a numerical model

[8] The EPA has developed a set of computerized analytical methods to use in wellhead protection area delineation. Copies of the software and documentation can be obtained by contacting the International Ground Water Modeling Center (Appendix C). There is a $50.00 fee to cover reproduction costs, and shipping/handling.

Figure 3. Illustration of an Analytically Derived Model



(a)



(b)

$$-\frac{Y}{X} = \tan\left(\frac{2\pi Kbi}{Q}\,Y\right)$$

Uniform-Flow Equation

$$X_L = -\frac{Q}{2\pi Kbi}$$

Distrance to Down-Gradient Null Point

$$X_L = \pm\frac{Q}{2\pi Kbi}$$

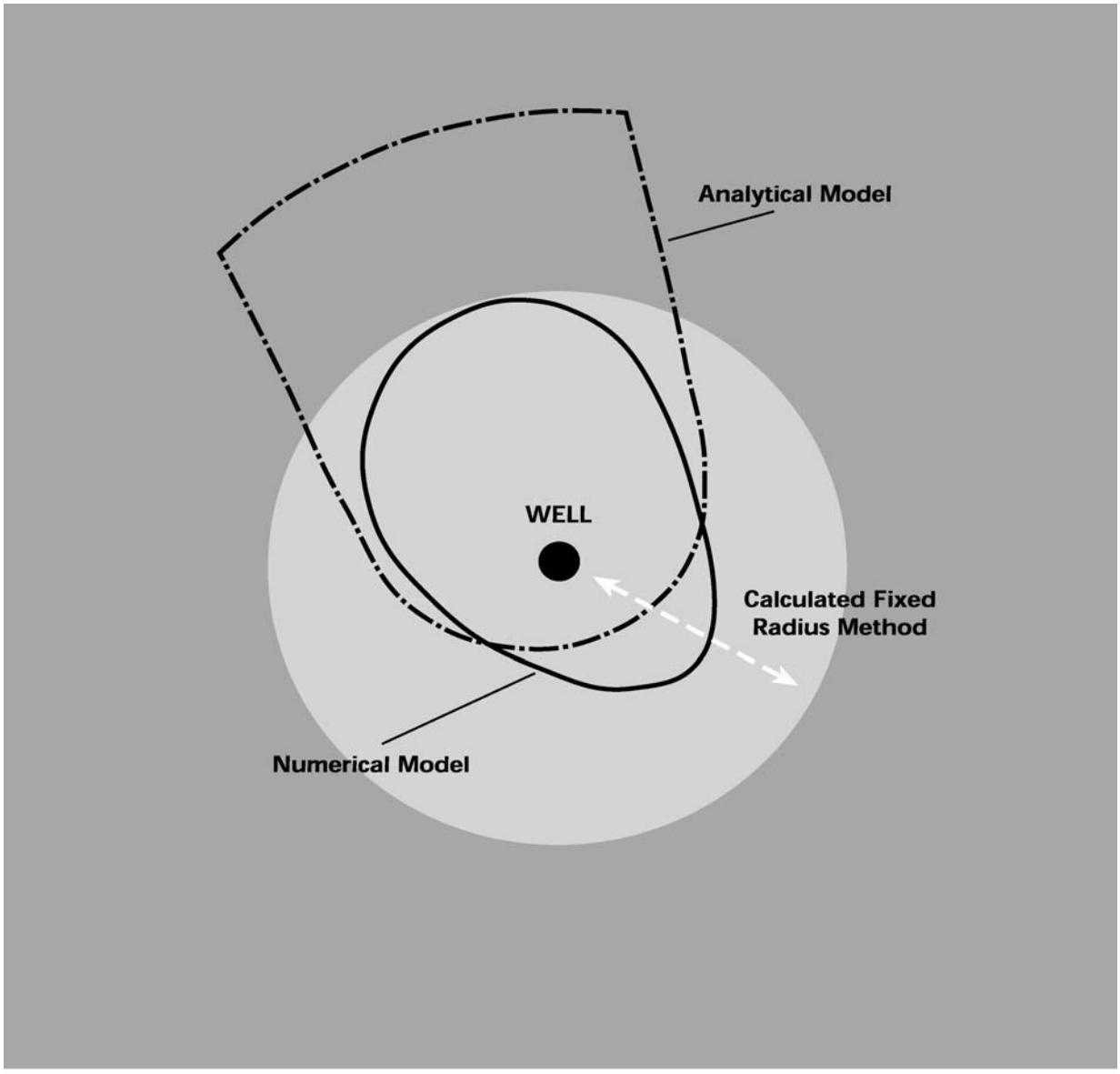
Boundary Limit

Legend:
- Pumping Well

Where:
Q = Well Pumping Rate
K = Hydraulic Conductivity
b = Saturated Thickness
i = Hydraulic Gradient
π = 3.1416

Source: United States Environmental Protection Agency, 1987.
Guidelines for Delineation of Wellhead Protection Areas.

**Figure 4. Wellhead Delineation Method Comparison*
Ten Year TOT Boundaries**



***Note:** This is a sample showing a comparison for 1 water system. Delineation at all wells may not follow this same pattern or exhibit similar differences.

was presented by EPA (**Figure 4**). Because there is wide variety in hydrogeologic settings, no set of examples should be considered typical.

Numerical models provide a very high potential degree of accuracy and can be applied to nearly all types of hydrogeologic settings. They may be very desirable in areas where there are other ongoing ground water management programs in place. Costs for this method are relatively higher than others, and considerable technical expertise in hydrogeology and modeling is required to use this method. However, the cost may be warranted in areas where a high degree of reliability is necessary.

Criteria Influencing Selection of Delineation Method

Site-specific delineation efforts are required for each public water supply well, wellfield or spring. Due to resource and information constraints, the initial minimum delineation method requirements are relatively unsophisticated (for most systems, the calculated fixed radius method).

Analytical methods can provide more reliable predictions of ground water flow than a calculated fixed radius method because they incorporate a greater number of site-specific parameters. When resources, site-specific information, and technical expertise are available, purveyors should delineate their wellhead protection area boundaries using analytical or other sophisticated approaches as soon as is practical.

When translating analytical predictions to boundaries on the ground, it is important to determine whether the results correspond well with the local hydrogeologic setting. Integrating a hydrogeologic mapping component (e.g. knowledge of hydrogeologic boundaries) into a model reduces the possibility of making improper assumptions about the ground water system. Incorporating knowledge of ground water flow divides and aquifer boundaries into the ground water model allows more accurate understanding of ground water flow patterns.

Sophisticated analytical methods, hydrogeologic mapping, and numerical ground water flow models allow a very site-specific approach to boundary area simulation, but require large amounts of site-specific data and technical expertise to run and interpret the model results. As a result, these types of applications are generally considerably more expensive than many of the simpler models. Detailed models are valuable tools for ongoing resource management and contingency planning and may be a wise investment for communities with resources available.

Assessment of Susceptibility

An important initial step in selecting the appropriate delineation method is to evaluate the susceptibility of the wells. DOH has prepared a ***Susceptibility Assessment Form*** which must be filled out by the purveyor for each well (Appendix E). **This is the same form DOH requires from purveyors applying for a monitoring waiver.** Assessment responses help determine which delineation methods are most appropriate.

Drinking water supplies vary in their susceptibility to contaminants discharged at the surface. A well's susceptibility increases when it is poorly constructed or improperly cased, or located in a geologic setting where no confining layer (aquitard/layer of lower permeability) exists between

the aquifer and the surface. Conversely, properly constructed and sealed wells, drawing water from deep below the surface, with several different impermeable layers overlying the aquifer are less susceptible to contaminants entering the surface at or near the wellhead. Washington's wellhead protection program groups wells into three classes of susceptibility: 1) high susceptibility, 2) moderate susceptibility, and 3) low susceptibility.

Assessment of Hydrogeologic Setting

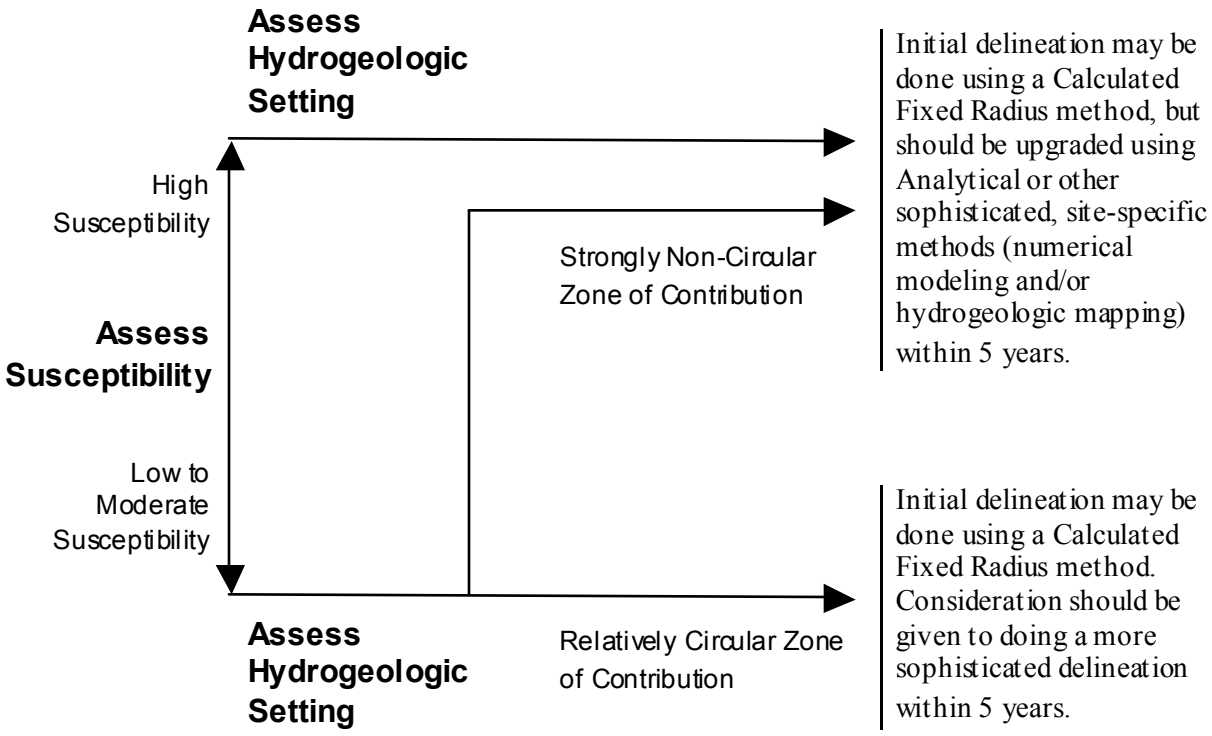
The initial wellhead delineation method required of most public water systems is the calculated fixed radius method. This is an inexpensive method to use as it only requires knowledge of a well's annual pumping rate, the length of the open (screened) interval and an estimate of the porosity of the aquifer. The model predicts concentric circles (circular zones of contribution) around the wellhead corresponding to the 1, 5, and 10-year time of travel of ground water flowing to the well. A major drawback of this model is that rarely does ground water behave simply as this model predicts. For this reason, public water systems using the calculated fixed radius method should evaluate the extent to which their hydrogeologic setting varies from a circular zone of contribution through the use of the susceptibility assessment form developed by DOH (Appendix E). Assessment responses help determine if delineation methods other than the calculated fixed radius method are more appropriate. This assessment process is the same one that DOH is using to evaluate water system's vulnerability for chemical monitoring requirements.

Selection of Delineation Method

Public Water Systems with Less Than 1000 Connections

The calculated fixed radius method is the minimum acceptable interim method of delineation for public water systems with less than 1,000 connections. A calculated fixed radius delineation should be conducted by July 1995. There are three scenarios under which the water system should give serious consideration to upgrading their initial delineation. They are: 1) if the susceptibility assessment form indicates that the system is highly susceptible, 2) if their hydrogeologic setting is strongly non-circular, or 3) if the results of the inventory reveal the presence of high risk potential contaminant sources. If any of these conditions exist, the public water supply should plan to upgrade the initial delineation to an analytical or other more sophisticated ground water flow model within five (5) years (**Figure 5**). If the system's contingency plan can not readily identify an alternate water supply in the event of source water contamination, DOH urges the system to upgrade the delineation using a more reliable method as soon as is feasible.

Figure 5. Delineation Method Selection Criteria for Public Water Supply Systems Having Fewer than 1000 Connections



Definitions

Analytical Methods: Site Specific modeling based on basic ground water flow equations.

Calculated Fixed Radius: A simplistic method for determining a circular protection area around a well for a specified time of (ground water) travel.

Non-Circular Zone of Contribution: Site-specific hydrogeologic parameters violating the assumptions inherent in the Calculated Fixed Radius modeling method.

Public Water Systems with 1,000 or more Connections

The minimum acceptable method of delineation for public water systems with 1,000 or more connections is determined based on the susceptibility assessment and hydrogeologic setting. If the system is highly susceptible, the initial delineation should be calculated using an analytical or other more sophisticated ground water flow method by July of 1996.

For those water systems found to be of low or moderate susceptibility, the minimum acceptable method of delineation is the calculated fixed radius method. DOH recommends that these water systems upgrade their initial delineation to a more sophisticated ground water flow model (**Figure 6**) within 5 years, particularly if the hydrogeologic setting is strongly non-circular or if the results of the inventory reveal the presence of high-risk potential contaminant sources.

Other Considerations

Delineation of Springs

Group A public water systems using springs as a source of supply are also required to develop a wellhead protection program as part of their water system plan or small water system management program. For technical assistance on delineating wellhead protection areas for springs, please contact DOH's Wellhead Protection Program Office.

Delineation of Multiple Wells

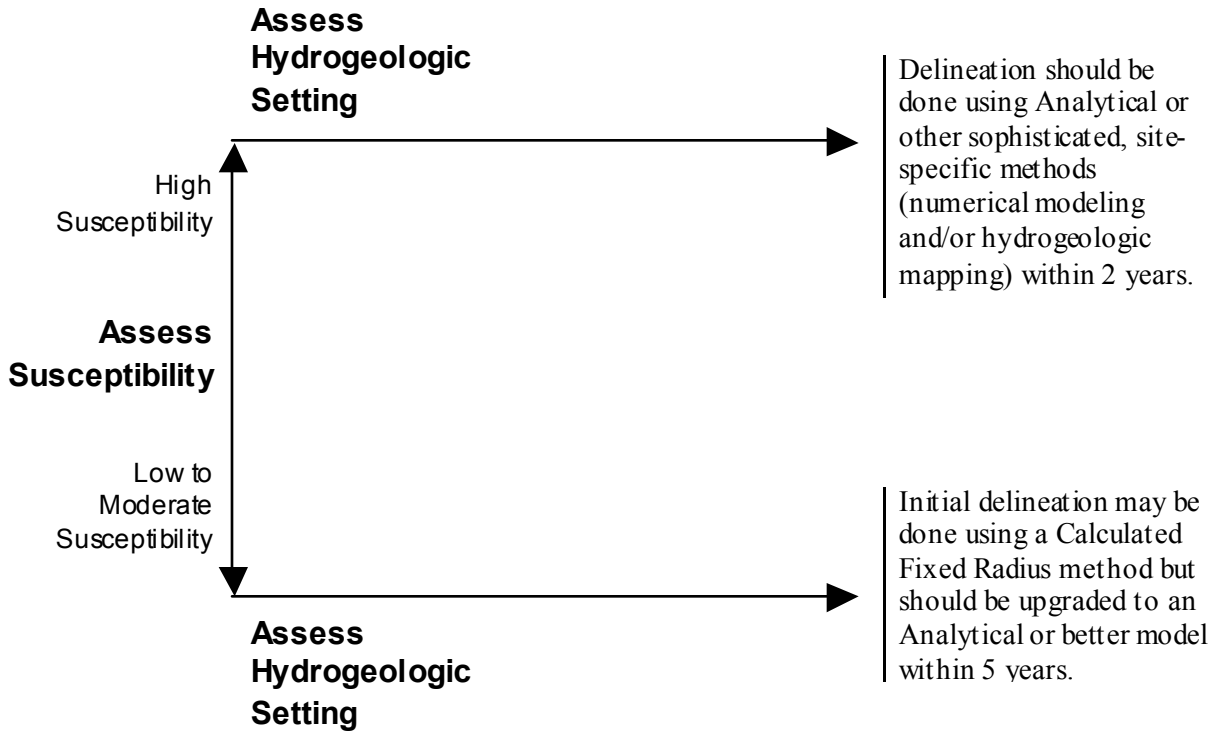
If the wellhead protection areas of wells overlap, and the Calculated Fixed Radius method was used, the wellhead protection area of the wellfield should be defined either by combining the wellhead protection areas of those wells (**Figure 7**) or by treating all the wells (combining pumping rates) as a single well located within the center of the wellfield. If other, more sophisticated modeling approaches were used, interference of the wells on one another should be incorporated into the modeling.

Refinement of Wellhead Protection Areas

Wellhead protection area boundaries should be periodically reviewed for changes. These include revised hydrogeologic data, changes in pumping capacities or rates, and new wells coming on-line. Changes in pumping rates or number of wells will likely require a new delineation of the wellhead protection area. Another reason to review is to confirm or reevaluate the potential contaminant sources within each of the zones. These are expected to change over time based on changes in land use as well as a result of management practices in place within each zone. The susceptibility assessment should be reevaluated on a periodic basis for the same reasons.

Redefining wellhead protection area boundaries (with the resulting need to update maps, re-inventory and notify owners/operator of potential contaminant sources and regulatory agencies) should only be undertaken when new information changes the boundaries significantly. It is suggested that revising wellhead protection area boundaries be considered during Water System Plan updating.

Figure 6. Delineation Method Selection Criteria for Public Water Supply Systems Having 1000 or More Connections

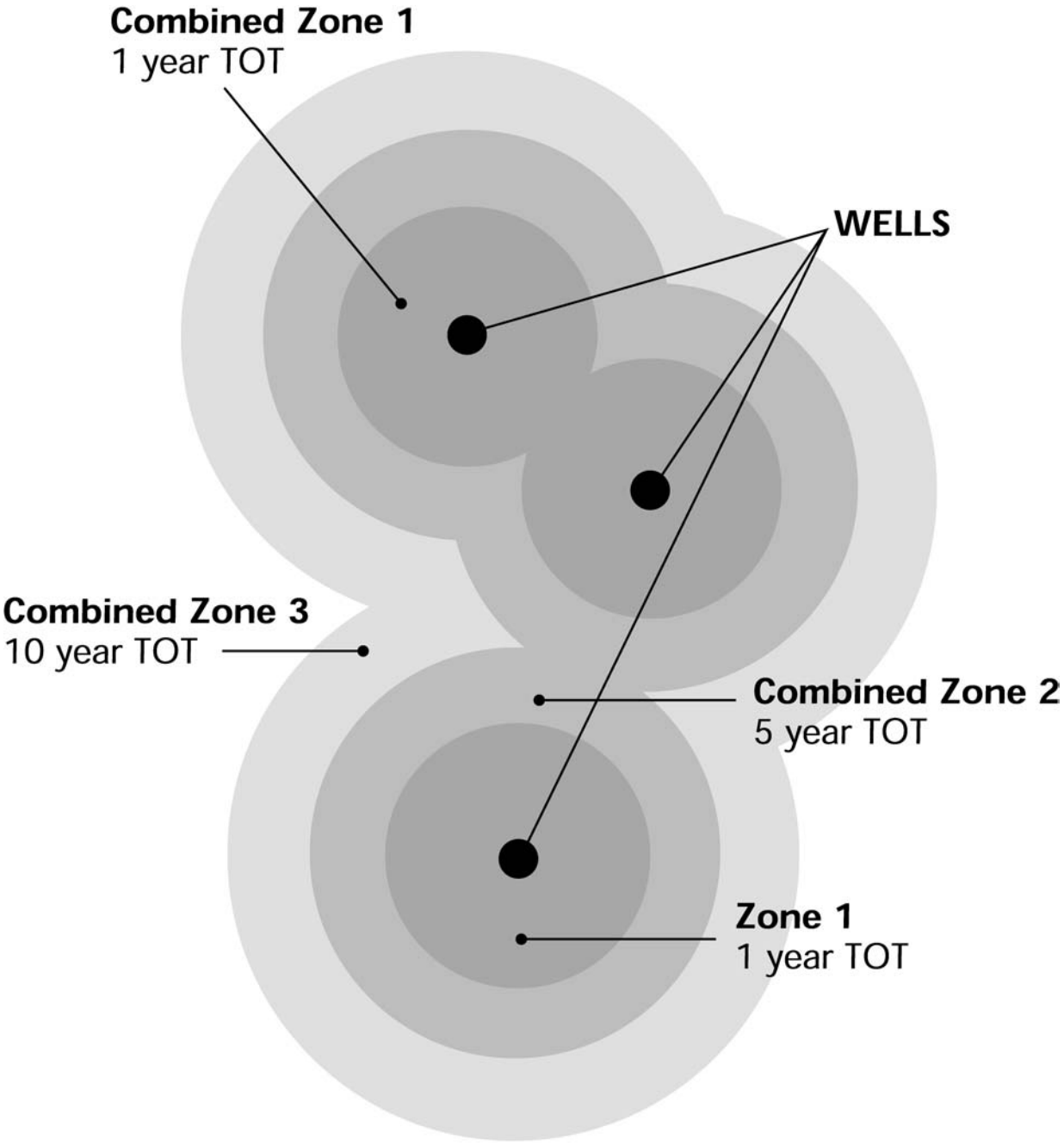


Definitions

Analytical Methods: Site Specific modeling based on basic ground water flow equations.

Calculated Fixed Radius: A simplistic method for determining a circular protection area around a well for a specified time of (ground water) travel.

Figure 7. Overlapping Wellhead Protection Area



When the Time of Travel Criteria is Inappropriate

There are areas in the state where the use of the 1, 5, and 10-year traveltime based criteria may not be appropriate. This may be due to:

- a capture zone which is recharged in less than 10 years,
- complicated geologic factors (river valley settings, high aquifer transmissivity, or complex geologic conditions that are not conducive to simplified modeling approaches), or
- settings where a significant portion of the contribution to the well is from surface water (wells adjacent to river systems, Ranney interceptor wells, or water-bearing zones having significant hydrologic continuity with surface waters).

In these settings, wellhead protection area zones established using alternative criteria instead of the basic time of travel criteria-or different time of travel criteria, may be more appropriate.

Prior to using alternate criteria, water system purveyors must contact DOH's Wellhead Protection Office and present the rationale for their conclusions. The purveyors must also propose alternate criteria or methods to be used for the delineation and wellhead protection zone boundary determinations. Deviations from the 1, 5, and 10-year time of travel criteria require DOH's concurrence.

Ground Water/Surface Water Interactions

Ground water and surface waters may be connected. This is referred to as hydraulic continuity. Wells located near rivers may draw a significant portion of their total withdrawal from the surface source. This is particularly true when the wells are lateral collector type wells such as Ranney wells. A connection between a well and a surface source may be established by examining water temperature fluctuation, or fluctuations in water chemistry of the well water which reflect changes in the surface water. Another method of identifying hydrologic continuity is by the correlation of water levels and impact of pumping on adjacent water levels both in surface waters and other wells.

If surface waters are discharging to the ground water, or the well is drawing water from surface supplies into its capture zone, that ground water supply may be considered by DOH as ground water under the direct influence of a surface water (GWI). A ground water source classified by DOH as a GWI may be subject to additional protection measures including surface watershed control plans, increased disinfection and possible filtration requirements reflecting risks traditionally associated with surface water. Most ground waters experience some degree of hydraulic continuity with surface water; however, the majority of ground water based public water systems will not be classified as GWIs by DOH.

Wells in direct hydraulic continuity with surface sources need to incorporate this fact into their delineation effort. Depending on the degree of connection, the surface source (river, lake) may serve as a hydrologic boundary and usually leads to a smaller wellhead protection area defined. Situations such as this will usually require professional assistance in delineation efforts.

The US EPA, in conjunction with the state of Oregon and the community of Boardman, funded a demonstration project examining procedures to follow when delineating in such settings. For more details on the results of this project, contact EPA Region X's Ground Water Section (Appendix C).

Specific Delineation Reporting Requirements

The wellhead protection area boundaries should be plotted on a base map that shows major landmarks and topography, with a scale large enough to adequately display the delineated area(s). A map with a scale of three to four inches per mile may be highly desirable. If you are unable to located a map of this scale, a 7 ½ minute U.S. Geological Survey topographic map can be used, if enlarged by photocopying. Prior to enlarging, draw a 1-mile bar of the correct scale on the map. Please ensure that the wellhead protection area boundaries on the map are drawn to scale as well.

If the Calculated Fixed Radius method is used, the following should be included in your water system plan:

1. Map of wellhead protection area delineations at the appropriate scale,
2. Screened interval of the well (or statement that well is of open hole construction),
3. Pumping rate of the well,
4. An example of the notification letter used, and
5. A listing of those notified of the wellhead protection area boundaries.

If a more site-specific method is used, the following should be included:

1. Map of wellhead protection area delineations at the appropriate scale,
2. Explanation of methodology used,
3. An example of the notification letter used, and
4. A listing of those notified of the wellhead protection area boundaries.

5. Inventory of Potential Sources of Ground Water Contamination

An essential element of wellhead protection is an inventory of all potential sources of ground water contamination (potential contaminant sources) in and around delineated wellhead protection areas. The purpose of the inventory is to identify past, present and proposed activities that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring or wellfield.

The list of potential contaminant sources derived from the inventory should be an accurate reflection of the actual risks posed to the drinking water supply. Depth of the well, its construction, the geology of the area, and the aquifer characteristics are all factors that influence what constitutes a "potential contaminant source". For example, a properly constructed deep well drawing from a confined aquifer will probably not be significantly at risk from septic systems. However, an improperly decommissioned well, which provides a conduit for contamination transport, does pose a risk to this system's source water.

Primary responsibility for the inventory rests with the public water system/purveyor. The limited abilities of non-governmental purveyors to conduct an effective inventory points out the need to form a local wellhead protection committee to coordinate inventory and other implementation efforts[9]. Partial inventories may have already been conducted for other purposes such as ground water management plans or watershed/nonpoint basin plans, and could be re-used by purveyors.

An inventory is a required component of a local wellhead protection program. Documentation must be provided in the Water System Plan or Small Water System Program document on how the inventory was conducted and what follow-up work was done by the public water system to contact both the identified potential contaminant sources as well as the federal, state, or local agency having jurisdiction over each potential contaminant source. An initial inventory should be completed within one year following wellhead protection area delineation. An initial inventory should include, at a minimum, all potential sources of contamination within Zone 1 (the 1-year time of travel), and high-risk potential contaminant sources within Zone 3 (the 10-year times of travel). The inventory must be updated every two years, at a minimum. In settings experiencing significant grown or changes in land use, the inventory should be updated on a more frequent basis.

Conducting an Inventory

DOH's technical assistance document *"Inventory of Potential Sources of Contamination within Washington's Wellhead Protection Areas"* will assist in the inventory process and can be obtained from DOH's Wellhead Protection Office (Appendix C).

The federal Office of Technology Assessment (OTA) has developed a comprehensive list of potential contaminant sources. This list classifies different types of potential contaminant sources into six major categories. These categories are based on the general nature of contaminants that

[9] Private systems often lack legal authority to obtain information from facilities located outside of their sanitary control area. If requests for information are refused, the fire marshal's office or the local health department may be better able to obtain the necessary information based on their public health and safety statutes.

Table 2. Potential Contaminant Sources Listed by Type

Category I—Sources designed to discharge substances

Subsurface percolation (e.g. septic tanks and cesspools)
Injection Wells
- Hazardous waste
- Non-hazardous waste (e.g. brine disposal and drainage)
- Non-waste (e.g. enhanced recovery, artificial recharge solution mining, and in-site mining)

Land application
- Wastewater (e.g. spray irrigation)
- Wastewater by-products (e.g. sludge)
- Hazardous waste
- Non-hazardous waste

Category II—Sources designed to store, treat, and/or dispose of substances; discharge through unplanned release

Landfills
- Industrial hazardous waste
- Industrial non-hazardous waste
- Municipal sanitary

Open dumps, including illegal
- dumping (waste)

Residential (or local) disposal (waste)
Surface impoundments
- Hazardous waste
- Non-hazardous waste

Materials stockpiles (non-waste)
Graveyards
Animal burial
Above ground storage tanks
- Hazardous waste
- Non-hazardous waste
- Non-waste

Underground storage tanks
- Hazardous waste
- Non-hazardous waste
- Non-waste

Containers
- Hazardous waste
- Non-hazardous waste
- Non-waste

Open-burning sites
Detonation sites
Radioactive disposal sites

Category III—Sources designed to retain substances during transport or transmission

Pipelines
- Hazardous waste
- Non-hazardous waste
- Non-waste

Materials transport and transfer operations
- Hazardous waste
- Non-hazardous waste
- Non-waste

Category IV—Sources discharging substances as a consequence of other planned activities

Irrigation practices (e.g. return flow)
Pesticide applications
Fertilizer applications
Animal feeding operations
De-icing salts applications
Urban run-off
Percolation of atmospheric pollutants
Mining and mine drainage
- Surface mine-related
- Underground mine-related

Category V—Sources providing conduit or inducing discharge through altered flow patterns

Production wells
- Oil (and gas) wells
- Geothermal and heat recovery wells
- Water supply wells

Other wells (non-waste)
- Monitoring wells
- Exploration wells

Construction excavation
Improperly abandoned wells

Category VI—Naturally occurring sources whose discharge is created and/or exacerbated by human activity

Ground water-surface water interactions
Natural leaching
Saltwater intrusion/brackish water upconing (or intrusion of other poor-quality natural water)

Adapted from: United States Environmental Protection Agency. 1989 *Wellhead Protection Programs: Tools for Local Governments.* EPA 440/6-89-002

Table 3. Potential Contaminant Sources Listed Alphabetically

Above ground storage tanks
Hazardous and non-hazardous waste treatment
Hazardous and non-hazardous waste storage
Hazardous and non-hazardous material storage

Animal feedlots

Containers
Hazardous and non-hazardous waste storage
Hazardous and non-hazardous material storage

Deep injection wells
Wastewater disposal wells
Oil and gas activity disposal wells
Mineral extraction disposal wells

De-icing salts and storage piles

Fertilizer applications

Graveyards

Ground water/surface water cross contamination

Irrigation practices (return flow)

Land application
Wastewater application (spray irrigation)
Wastewater by-product (sludge) application
Petroleum refining waste application
Hazardous and non-hazardous waste application

Landfills
Industrial hazardous and non-hazardous landfill
Municipal sanitary landfill

Material transfer operations
Hazardous and non-hazardous waste transfers
Hazardous and non-hazardous material transfers

Material stockpiles
Hazardous and non-hazardous material

Mining and mine drainage

Natural leaching

Open Dumps

Pesticide applications

Pipelines
Hazardous and non-hazardous waste storage
Hazardous and non-hazardous material storage

Radioactive disposal sites

Salt-water intrusion

Septic tanks
Houses
Apartments
Small businesses

Shallow injection wells
Agricultural drainage wells
Automobile service station disposal wells
Industrial process water disposal wells

Storm water drainage wells

Surface impoundments
Hazardous and non-hazardous waste
Cesspools, ponds, lagoons, and other impoundments

Transportation of materials
Hazardous and non-hazardous waste
Hazardous and non-hazardous material

Underground storage tanks
Hazardous and non-hazardous waste treatment
Hazardous and non-hazardous waste storage
Hazardous and non-hazardous material storage

Urban runoff

Waste piles
Hazardous and non-hazardous waste piles

Waste tailings
Heap leaching piles
Non-heap leaching piles

could be released to ground water (**Table 2**). Another list, based on this OTA list, is organized as an alphabetical listing of contaminant sources (**Table 3**). The alphabetical listing is an important tool in thinking about potential contaminant sources. An advantage of the category list presented in Table 2, however, is that it is not limited to specific sources. It enables one to look at facilities and activities with an eye toward all potential sources of ground water contamination. Neither of these are exhaustive collections, and there may be sources in a particular municipality that are not mentioned here.

When inventorying, it is important to note that one facility may have several different potential contaminant sources. For example, a gasoline/service station may have an underground storage tank, a shallow drain, or dry well and an onsite septic system.

There are a variety of techniques used to identify contaminant sources, either independently or in conjunction with other approaches. Common techniques utilize existing data, surveys, and field studies.

Existing Data

In most municipalities, a substantial amount of information on past, current, or potential contaminant sources exists in the form of routine records or documents. It is important to include past land uses in the inventory since, for example, leaking underground storage tanks may be found at the site of an abandoned/converted gas station. Information regarding past land uses can be obtained from such sources as old aerial photographs, historical maps, tax assessor's maps/plats, and interviews with long-term community residents.

Sources of information for current land uses include:

- recent aerial photographs,
- telephone directories,
- business licenses,
- federal, state and local databases dealing with commercial permits,
- zoning regulations,
- health regulations,
- construction permits, and
- real estate title searches.

State and local regulatory agencies maintain a variety of information databases to track permitted activities or facilities within their jurisdiction. These databases range from computerized systems to file drawers.

An excellent document which lists public databases of known or potential contaminant sources is the *Catalog of Contaminant Databases*. This 1991 Washington State Department of Ecology catalog can be obtained from DOH's Wellhead Protection Office (Appendix C).

It is important to remember that even if information from databases is readily available, the listings will only identify facilities that are required to file information under existing regulations ***and have complied with the requirements***. Other inventory approaches must be used to identify unpermitted facilities.

Surveys

Once existing data for wellhead protection areas has been researched and recorded, data gaps can be identified. The need for gathering additional information and/or verifying recorded data can be assessed. The most comprehensive method of obtaining additional information is generally by a survey. Types of surveys include:

- mail questionnaires,
- telephone surveys,
- windshield surveys,
- door-to-door surveys, and
- personal interviews.

Field Searches

Inventories for potential contaminant sources often include field searches of some or all of the area being inventoried. Field searches allow inventory workers to look at the survey area themselves, without relying on landowners to identify and provide information about sources. Field searches are conducted much like door-to-door surveys and require the same amount of planning but often require more time to complete. Field searches consist of an extensive foot survey of an area, and are often used when a particular situation calls for a detailed inspection of land uses.

Modifying Inventory Approaches to Address Local Settings

Few public water supplies or communities need to conduct mail, phone, door-to-door surveys, ***and*** field searches, as this would gather a large amount of repetitious information at a high cost. Which methods are used will depend upon the situation of the community conducting the inventory. If resources are not available for some of the more labor-intensive methods, various means may be used to reduce the efforts without losing their value. The use of volunteer organizations, or local public service groups, should always be considered when resources are limited. Ideally, each community should strive to conduct the most complete inventory possible given their situation and the resources available to them.

It is important to remember that the information gathered from the inventory needs to be updated regularly, perhaps more frequently than the two-year minimum requirement. The intervals necessary between updates will vary with each municipality; rate of growth will be a big factor in making this determination. It may be possible to update the inventory automatically, i.e. when a new business opens in a wellhead protection area, it could be immediately entered into the database.

Prioritizing Inventory Efforts

Method(s) of inventorying within the wellhead protection area, and the outreach to both identified potential contaminant sources and agencies with jurisdiction over them, need to be included within the public water system's Water System Plan or the Small Water System Management

Program document. DOH recognizes that conducting a comprehensive inventory for all potential sources of ground water contamination within a large wellhead protection area will require time. Inventory efforts should be prioritized using two criteria. The first is working out from the wellhead. The most intensive efforts should be initially focused within Zone 1, the one-year time of travel area. Then the inventory area should be expanded outwards to include Zone 2 and Zone 3.

The second prioritizing criteria is to initially focus on high and medium risk facilities and activities within the entire wellhead protection area. While what constitutes a high risk potential source will vary from location to location, there are certain types of operations which pose a potential threat in almost all settings. Improperly decommissioned (abandoned) wells, underground storage tanks, dry cleaning operations, chemical wholesale operations, and electroplating facilities, for example, all have a high potential for seriously impacting ground water quality. Because the total number of high and medium risk operations is typically low, detecting and contacting them should not be a labor-intensive task.

An inadequate inventory or outreach effort will result in DOH not approving the planning document.

Prioritizing Inventory Findings

Information gathered through the inventory process can be used to help establish action priorities within the wellhead protection area. Risks posed to the wellhead protection area can be evaluated and management efforts can be directed towards high priority sources. When assessing the relative risks posed by a variety of potential contaminant sources, the type of material/activity, quantity, and method of storage and handling should all be taken into account.

A relative risk assessment will aid the purveyor/community in:

- determining a risk "score" for each potential source,
- ranking each source according to the level of risk associated with it, and
- determining the relative level of threat that a given source poses (high, medium, or low).

This approach allows an initial screening of potential contamination sources on the bases of relative risk, without complicated risk assessments. It may not, however, be an adequate substitute for site-specific, detailed risk assessments. Using this technique, local managers can develop an initial priority list for focusing implementation efforts without allocating substantial amounts of funds. This process can be used either for potential contaminant sources within a single wellhead protection area, or over a larger geographic area for multiple wellhead protection areas.

Documenting Inventory Efforts

The following must be included in the wellhead protection program portion of either the water system plan or the small water system management program:

1. A list of all potential and known sources of ground water contamination (past and present) within the wellhead protection area boundaries that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring or wellfield. The inventory findings should be prioritized and grouped by time of travel zones. This list is required by WAC to be updated at least every two years.

2. Documentation that the purveyor has notified the correct regulatory agencies and local governments of the location of potential and known sources of ground water contamination within the wellhead protection area boundaries. An example notification letter should be included, along with a list of all entities notified.

3. Documentation that all owners/operators of known and potential sources of ground water contamination have been notified of their location within the wellhead protection area boundaries. An example notification letter should be included, along with a list of all entities notified.

Highly susceptible systems with 1,000 or more connections should also include:

1. Current land use/zoning designation of the wellhead protection area(s),

2. A priority ranking of potential contaminant sources (high to low).

6. Wellhead Protection Area Management Strategies and Implementation

Management Overview

Without implementation of risk reducing measures or pollution prevention efforts, a local wellhead protection program will not protect the water supply. Management strategies cannot be focused until a clearly defined wellhead protection area has been established and specific potential sources of ground water contamination identified.

Dissemination of the findings of the inventory to regulatory agencies and the owners/operators of the facilities and activities constitutes an important implementation component of local wellhead protection programs. A public education outreach program should be tailored to address local needs and situations.

Effective implementation of a local wellhead protection program can be accomplished through existing authorities at the local, state, and federal levels. Because land use control is an essential component of wellhead protection implementation, municipal tools such as inspections, permitting, enforcement, and zoning are important. By exercising these mechanisms at the local level, a community serves notice that the local wellhead protection program is an "official" program important to its citizens. It sends a clear message that persons responsible for potential contaminant sources within wellhead protection areas will be accountable in managing their activities/facilities responsibly.

At the state and federal level, DOH and EPA's Office of Water are working with other state and federal programs and agencies to ensure that local wellhead protection programs, and their inventory data, are integrated into existing state and federal contamination source control measures.

Establishing a Local Wellhead Protection Committee

Many public water systems are owned or operated by private entities. Many wellhead protection areas in Washington will lie, at least in part, in areas outside the jurisdiction of the purveyor. Land use may be controlled by other communities, counties, states, or nations. Cooperation from authorities in other jurisdictions is essential for effective protection of the resource. To help resolve multi-jurisdictional issues, DOH promotes and encourages establishment of a local wellhead protection committee. Participants should include jurisdictions with land use controls over the wellhead protection area; public water system(s); local planning agencies; regulatory agencies; tribes; industrial, commercial, and agricultural organizations; and citizen action groups. In many locations, an existing group such as a Water Utility Coordinating Committee or a Ground Water Advisory Committee may serve as the core membership of the local wellhead protection committee.

By coordinating the efforts of independent water systems, jurisdictions, and affected parties as the local program evolves, a consensus can develop as to what constitutes an appropriate

management program. Coordinating efforts may also provide significant cost savings when delineating and inventorying. Spill response plans and contingency plans also benefit from coordinated, integrated planning efforts.

An important early step is designation of a lead agency to coordinate local wellhead protection activities. In many instances, an appropriate lead may be the local health department or local planning agency.

Individual Potential Contaminant Source Management

After conducting an inventory, the public water system purveyor shall notify potential contaminant sources that they are within a wellhead protection area. Currently regulated potential contaminant sources also need to be reported to the proper local, state, or federal agency. Potential contaminant sources for whom no lead agency can be determined should be identified to both the local jurisdiction and DOH. When available, potential contaminant sources will be given technical assistance on pollution prevention and risk reduction steps to minimize the possibility of causing ground water contamination[10]. Education of owners/operators of potential contaminant sources, and voluntary adoption of Best Management Practices (BMPs) by them, are important first steps in implementing protective measures.

Federal, state, and local agencies and programs will determine how to best manage potential contaminant sources located within wellhead protection areas based on jurisdictional responsibilities, hydrogeologic settings and other factors.

As implementation efforts begin, potential contaminant sources which cannot be effectively managed through education or the voluntary use of BMPs will be identified. As these potential contaminant sources are identified, the federal, state, or local agency with primary jurisdiction and regulatory responsibility should develop proposed procedures and/or rules and regulations to address protection of the wellhead protection area. Specific permitting requirements for activities undertaken within a wellhead protection area may be incorporated into the permitting processes of the participating agencies.

Potential contaminant sources for which no responsible agency or program can be identified will be brought before the Interagency Ground Water Committee (IGWC) for evaluation and discussion. The IGWC will appoint a subcommittee to research the question of jurisdiction and present its findings back to the IGWC. It will also share the results of its research with the agencies which may have jurisdiction and/or to the Legislature for possible legislative action if no lead agency can be determined.

Developing a Pollution Prevention Program

Identification of potential contaminant sources will be meaningless unless steps are taken to prevent potential threats from becoming actual problems. DOH encourages communities to adopt pollution prevention strategies. Pollution prevention is a long-term waste management technique that aims to reduce or eliminate waste at its source. Using data from the potential contaminant

[10] This will be done primarily by the agency with jurisdiction over the potential contaminant source. DOH will work with public water systems, other agencies, and potential contaminant sources to identify technical assistance information and aid in its distribution.

source inventory, facilities that can benefit from pollution prevention technical assistance can be targeted. Three categories of pollution prevention techniques recognized by EPA include:

Source reduction—This technique involves several process modifications designed to reduce the amount of waste generated. These include: changes to input materials, equipment and other technological changes; redesigning processes to reduce waste generation; maintaining and managing equipment and materials to minimize the opportunity for accidental releases; waste separation to improve recovery of usable materials; and employee waste minimization training and supervision.

Recycling—This involves the use, reuse, or reclamation of a waste product as a substitute for raw materials or ingredients. Recycling can occur on-site, or it can be done off-site by recycling services or waste exchanges.

Treatment—This technique involves processing hazardous waste after it is produced to reduce toxicity or volume. This is the least preferred pollution prevention technique since treatment involves the production of wastes. However, treatment is preferred over the disposal of raw waste materials.

For general information on developing a pollution prevention program, contact the Department of Ecology's Recycling Hotline (Appendix C). For more detailed information, or to request an onsite assessment to identify pollution prevention opportunities for your facility, call your nearest Ecology regional office (Appendix C), and ask to speak with a toxics reduction specialist.

Management Tools for Local Governments

Local governments have a key role in implementing local wellhead protection programs. Many potential contaminant sources can only be effectively managed through local land use planning, local performance standards, or other local measures. Such measures may be developed as part of a local ground water management area plan.

The management strategy of a local wellhead protection program should be to establish policies and procedures designed to protect ground water used as public drinking water. Management options and choices will be defined by several factors including:

- Size of system (number of connections),
- Type of system (community, non-community, transient),
- Vertical travel time,
- Hydrogeologic setting (susceptibility), and
- Lack of alternate sources of supply.

Because each water system faces different ground water threats, implementation issues, and hydrogeologic settings, no single wellhead protection tool or set of tools can be applied universally. Rather, the various tools available for ground water protection should be evaluated based on the local conditions.

There are, however, some management options, both regulatory and non-regulatory, that have proved useful in a variety of settings:

- Bonding
- Design Standards
- Ground Water Monitoring
- Household Hazardous Waste Collection
- Operating Standards
- Overlay Zones (e.g. Environmentally Sensitive Areas affecting SEPA review process)
- Public Education and Outreach
- Purchase of Property or Development Rights
- Site Plan Reviews
- Source Prohibitions
- Spill Reporting Requirements
- Subdivision Ordinances
- Voluntary/Mandatory use of Best Management Practices
- Water Conservation Measures
- Wellhead Protection Area Boundary Signs for transportation corridors
- Zoning Ordinances

An overview of many of these management options is found in **Table 4**, with more detailed coverage presented in the EPA document: *Wellhead Protection: Tools for Local Governments.*

EPA has compiled a collection of approximately 240 local ordinances from across the country related to ground water protection/wellhead protection. A copy of this collection is stored at the Municipal Research and Service Center (Appendix C).

Table 4. Management Tools for Local Governments

Best Management Practice. BMPs are voluntary actions that have a long tradition of being used, especially in agriculture. Technical assistance for farmers wishing to apply them is available from local Cooperative Extension and SCS offices.

Bonding. Facilities may be required to post a bond prior to operation in a WHPA. Bond can cover costs associated with spill response or remediation efforts.

Building Codes. Local building codes offer protection through special standards applicable to facilities which are remodeled or constructed in the WHPA. Building codes can also require low flow fixtures, backflow preventers and other design features to conserve and protect ground water.

Contingency Planning. Local governments can develop their own contingency plans for emergency response to spills and for alternate water supply following contamination of the current wellfield.

Design Standards. Design standards typically are regulations that apply to the design and construction of buildings or structures. This tool can be used to ensure that new buildings or structures placed within a WHPA are designed so as not to pose a threat to the water supply.

Ground Water Monitoring. Ground water monitoring includes selecting appropriate sampling sites upgradient of well and developing an ongoing water quality monitoring program.

Inspection and Testing. Local governments can use their statutory home rule power to require more stringent control of contamination sources within WHPAs.

Operating Standards. Operating standards are regulations that apply to ongoing land-use activities to promote safety or environmental protection. Such standards can minimize the threat to the WHPA from ongoing activities such as the application of agricultural chemicals or the storage and use of hazardous substances.

Public Education. Public education often consists of brochures, pamphlets, or seminars designed to present wellhead area problems and protection efforts. This tool promotes the use of voluntary protection efforts and builds public support for a community protection program.

Purchase of Property or Development Rights. The purchase of property or development rights is a tool used by some localities to ensure complete control of land uses in or surrounding a WHPA. This tool may be preferable if regulatory restrictions on land use are not politically feasible and the land purchase is affordable.

Site Plan Review. Site plan reviews are regulations requiring developers to submit for approval plans for development occurring within a given area. This tool ensures compliance with regulations or other requirements made within a WHPA.

Source Prohibitions. Source prohibitions are regulations that prohibit the presence or use of chemicals or hazardous activities within a given area. Local governments can use restrictions on the storage or handing of large quantities of hazardous materials within a WHPA.

Subdivision Ordinances. Subdivision ordinances are applied to land divided into two or more subunits for sale or development. Local governments use this tool to protect WHPAs in which ongoing development is causing contamination.

Training and Demonstration. These programs can complement many regulations. For example, training underground storage tank inspectors and local emergency response teams, or demonstration of agricultural BMPs.

Waste Reduction. Residential hazardous waste management programs can be designed to reduce the quantity of household hazardous waste being disposed of improperly.

Zoning Ordinances. Zoning ordinances typically are comprehensive land-use requirements designed to direct the development of an area. Many local governments have used zoning to restrict or regulate certain land uses.

Zoning Overlay. Overlay zones can be used in conjunction with conventional zoning to create special districts to protect the WHPA. Overlay zones are applied to areas singled out for special protection, and add regulations to those controls already in place. This method helps address "grandfathered" potential contaminant sources in WHPAs.

Source: United States Environmental Protection Agency, 1989.
Wellhead Protection Programs: Tools for Local Governments. EPA 440/6-89-002

7. Contingency Plans

Subsection 1428(a)(5) of the 1986 Amendments to the Safe Dirking Water Act (Appendix A) specifies that state programs require public water systems to develop contingency plans *"...for the location and provisions of alternate drinking water supplies for each public water system in the event of well or wellfield contamination..."*. In the state of Washington, contingency plans are a required component of the Water System Plan pursuant to WAC 246-290-100 and the Small Water System Management Program under WAC 246-290-410.

Contingency planning is important for all systems because, even with careful planning, unforeseen incidents can occur. Ground water contamination can still occur due to leaks, spills, accidental releases, illegal discharges and other activities in and around the wellhead protection area. A properly prepared and updated contingency plan helps ensure the water system, and local officials, are prepared to respond to emergency situations and able to provide alternative sources of drinking water.

Developing a long-term contingency plan can be a very educational experience. Jurisdictions that cannot identify economically feasible alternative long-term drinking water supplies may require and desire a more stringent management program to prevent contamination.

Both short and long-term alternative drinking water supplies should be identified in the contingency plan. For example, to prevent contaminants from reaching a well, it may be necessary to cease pumping until remedial actions can be taken. In the worst-case scenario, a purveyor may need to abandon a well due to contamination. When developing contingency plans, the water system/purveyor should:

1. Identify maximum water system capacity in relation to source, distribution system, and water rights restrictions. Assume loss of largest well/wellfield and reevaluate;

2. Evaluate the expansion options of the existing system's capacity to meet current water rights/availability;

3. Identify existing or potential interties[11] with other public water systems and evaluate the ability to deliver water assuming loss of largest well/wellfield, include costs associated with the purchase and/or delivery of alternate supplies;

4. Evaluate current procedures and make recommendations on contingency plans for emergency events;

5. Identify future potential sources of drinking water and describe quality assurances and control methods to be applied to ensure protection of water quality prior to utilization as a drinking water supply; and

6. Maintain a current list of appropriate emergency phone numbers.

[11] Interties are physical connections (pipes) between different water systems allowing for the transfer of water. Prior to water being shared between systems, careful investigation of engineering considerations and issues related to water rights and use of water outside of designated service area is required.

Costs associated with obtaining alternative sources of supply, in both the short and long term, should be estimated within the contingency plan section. In the event that analysis shows no alternative sources of supply or interties are available, the contingency plan should clearly state this and then proceed to analyze treatment options for the potential contaminant sources determined to pose the highest risk to the source of supply.

Efforts should be made to coordinate contingency plan development with other existing or on-going contingency planning such as the work conducted by your local emergency planning committee (LEPC)[12] under SARA Title III. For many systems, it will be important to work with the local or regional wellhead protection committee if a realistic contingency plan is to be developed.

The contingency plan should be complete within one (1) year of the wellhead protection area boundaries being delineated, with suggested updating every two years; more often if the situation warrants.

[12] LEPCs were established under the Superfund Act Reauthorization Amendments (SARA Title III).

8. Spill / Incident Response Planning

As part of a local wellhead protection program, the public water system must coordinate with local emergency responders (e.g. police, fire departments), the Department of Ecology's Spill Operations Section, the Department of Community Trade and Economic Development's Emergency Management Program, the local health department, and any local emergency planning committee. Using the results of the susceptibility assessment and the findings of the wellhead protection area inventory, local emergency responders should evaluate whether changes in incident/spill response measures are needed to better protect ground water quality within wellhead protection areas. If a public water system's source water is determined to be vulnerable to surface activities, special procedures may need to be incorporated into local emergency response plans.

Changes in response may be as simple as ensuring that sufficient quantities of absorbents are on hand to respond to a large transportation spill, or recognition that in the event of a fire, it may be best to allow certain facilities or structures to burn rather than have contaminated runoff pollute the community water supply.

Appropriate spill / incident response measures must be determined prior to an incident occurring. Deviations from the standard operating procedures will only happen if reasons for the deviation are explained and accepted. This does not happen easily while responding to an on-going crisis.

For many systems, it will be important to work with a local wellhead protection committee if a realistic spill / incident response plan is to be developed. Coordination with the local Emergency Planning Committee (LEPC), and/or other local emergency management entities is also important.

Spill / incident response coordination should be completed by July 1996 for those systems using the CFR method of delineation. Systems using more sophisticated modeling methods have one year following the delineation of their wellhead protection area (July 1997) in which to coordinate with local emergency responders. Spill / incident response plans should be reviewed / updated at least every two years, more often if the situation warrants.

Documentation of the coordination outreach should be provided in your water system planning document.

9. Wellhead Protection Requirements for New Public Water Supply Wells

WAC 246-290-130 requires, in part, that before a new or modified public water supply receives DOH approval:

- a susceptibility assessment be completed;
- a wellhead protection area be delineated; and
- potential sources of contamination of the water bearing zone (aquifer) utilized by the well, spring or wellfield be identified.

As part of the source approval process, the purveyor will be required to delineate a wellhead protection area, using a calculated fixed radius method. The delineation should be computed using the best available data such as an estimated well screen interval and a pumping rate based either on the water right quantity or number of connections.

An inventory must then be conducted within the wellhead protection area. The purpose of the inventory is to identify past, present and proposed activities that may pose a threat to the source of supply. The vulnerability of the source water of the proposed new well, along with potentially increased and on-going monitoring requirements, should be weighed against the costs of selecting an alternate well site.

As is currently the procedure under WAC 246-290-135(2) Source Protection: *"The department may require monitoring and controls in addition to those specified in this section if, in the opinion of the department, a potential risk exists to the water quality of a source."* Information generated during the inventory will be used to determine whether additional water quality monitoring is needed.

Also, all new public water wells must be tagged with a State of Washington Well Identification Tag[13] and the number reported to DOH.

Once a new source has been approved by DOH, the purveyor must develop a complete wellhead protection program as defined in WAC 246-290-135.

[13] Contact Ecology's Water Resource Well ID program for more details on well tagging (Appendix C).

10. Local Wellhead Protection Program Financing

This section provides a general overview of potential funding mechanisms for local wellhead protection programs. A more detailed discussion can be found in the EPA document: *Local Financing for Wellhead Protection*. Contact EPA Region X's Ground Water Section for information on how to obtain a copy (Appendix C).

Projected Statewide Implementation Costs

An estimate of the direct costs of implementing wellhead protection statewide during the program's first five years is $5,355,000, based on the minimum standards of delineation established under DOH's WAC requirements and guidelines. Data and assumptions for this estimate are presented in **Table 5**. Values were calculated using past Centennial Clean Water Fund grant awards, input from the Technical Advisory Committee, and best professional judgment. The estimate includes costs of delineation, inventory, development of initial management plan, contingency and spill response planning. There are indirect implementation costs not factored into the calculations. Direct costs to a water system can range from $500-$450,000+ depending on such factors as: number of connections, vulnerability, hydrogeologic setting, desired accuracy of ground water modeling, and the extent and nature of planning. Cost per connection also varies, with preliminary estimates predicting a per household increase of $0.08-0.67 per month over a five-year period. The actual cost of implementation may be significantly higher than indicated, depending on the number of systems which decide to invest more into ground water modeling, inventory efforts, and management activities than the state program requires.

Funding Sources

There are three general sources of funds for implementing local wellhead protection programs:

- Local taxes or fees,
- Private sector investments, and
- Intergovernmental assistance (grants/loans).

Local Taxes/Fees

Generating revenue through local taxes or fees presents many options. In Washington, several communities are funding local ground water protection efforts using a variety of mechanisms. Spokane County dedicates a portion of its sales tax receipts to ground water protection efforts. The City of Olympia recently established impact fees on new development. Local health departments may be able to collect fees for permits and inspections of facilities within wellhead protection areas. The City of Bellevue created a service fee to recover the cost of drainage improvements and ground water protection.

Table 5. Projected 5-Year Direct Implementation Costs

Number of Connections	Number of Systems	Delineation Multiplier	Estimated 5 year Cost per System	Monthly Cost per Connection	Total Cost per Group
10,000+	14	0.20[14]	$15,000[15]-100,000	$0.01-0.17	$448,000
2,5000-9,999	56	0.20	$10,000-60,000	$0.02-0.40	$1,120,000
1,000-2,499	69	0.20	$7,500-40,000	$0.05-0.67	$966,000
500-999	95	1	$5,000	$0.08-0.17	$475,000
100-500	351	1	$5,000	$0.07-0.33	$702,000
50-99	429	1	$2,000	$0.34-0.67	$858,000
15-49	1063	1	$500	$0.17-0.56	$531,500
Transient, non-community	509	1	$500		$254,500
Estimated Costs of Implementation: 1994-1999					**$5,355,000**

[14] -20% of systems having 1,000 or more connections are expected to have a rating of "highly susceptible" and therefore will require use of analytical or other sophisticated delineation methods, with the remainder using a calculated fixed radius method as their delineation approach.

[15] The cost of using a calculated fixed radius method for delineation is estimated to increase as the number of connections increases. This is due to both the increasing size of the individual delineation areas (as a result of higher pumping rates) as well as an increase in the number of wells or wellfields per system.

Once wellhead protection areas or other aquifer protection areas are established, RCW 36.36 provides a process for fees to be collected to fund ground water protection efforts including wellhead protection implementation efforts. In order to be granted legislative authority to propose a ballot measure to impose a monthly fee on water withdrawals or on-site sewage disposal, a community must designate an Aquifer Protection Area/Aquifer Protection District. The monies generated can be used to fund a variety of ground water protection efforts, including wellhead protection. A major value of this mechanism is that it allows local governments to establish a stable funding base for wellhead protection implementation efforts.

Private Sector Investments

Privately owned public water systems are responsible for financing their own local wellhead protection program. Regardless of regional support, purveyors may need to cover costs associated with delineation, initial inventory for potential contaminant sources, spill response plan development, contingency planning, and documentation in their Water System Plan. Appropriate unit charges (fee per connection, charge per gallon used) and access fees should be evaluated as funding sources. Rarely are privately owned public water systems eligible for local, state, or federal grant/loan programs. By working with other purveyors and local governments, implementation costs may be reduced.

Grants and Loans

There are limited grants and loans available at both the state and federal level which can be used to initiate development of local wellhead programs. At the federal level, the EPA has traditionally offered one or more wellhead protection demonstration grants to local governments in Washington. Contact EPA Region X for more details (Appendix C). Currently, no additional federal Wellhead Protection demonstration grants to local governments are being offered.

At the state level, two loan programs and a grant program provide financial support to local governments implementing local wellhead protection programs. Under certain conditions, a loan can be a better source of financial assistance than a matching grant. Consideration should also be given to pursuing both grant monies and a loan when developing a local wellhead protection program. The loan may be used to provide some or all of the grant match.

The Department of Ecology administers both the Centennial Clean Water Fund (CCWF) and the State Revolving Fund (SRF). The CCWF provides matching grants to public bodies for projects that protect water quality. Wellhead protection planning and/or implementation are eligible types of projects (Reference Table 1 for a list of previously funded local wellhead programs).

Ecology also administers the SRF program. The SRF can provide low interest loans to public bodies for implementation of part or all of a local wellhead protection program. It provides loans to high priority water pollution control projects, both facilities (structures) and activities. For more details on eligibility and how to apply for CCWF grants and SRF loans, contact Ecology's Water Quality Program (Appendix C).

The Department of Community Trade and Economic Development's Public Works Trust Fund (PWTF) Program provides low interest loans (0-5%) to help local governments finance needed public works projects or planning-including wellhead protection programs. The PWTF Program

welcomes inquiries. Staff is available to discuss how the PWTF might be used by your community or to answer general questions on how the program operates (Appendix C).

The Rural Economic and Community Development Administration has a loan/grant program for water and/or sewer projects for rural water districts, non-profit rural water companies, and municipalities which serve less than 10,000 persons. Wellhead protection can be included as a component of water projects. Please contact the Rural Economic and Community Development Administration for more details (Appendix C).

The Indian Health Service has funds which can be used to assist water system improvements if the system serves Indian families. During 1992, the Indian Health Service hosted workshops in Washington State on wellhead protection for Indian tribes (Appendix C). In 1994, EPA provided funds and technical assistance to Tribes in Washington for wellhead protection area delineations and inventories.

11. Relationship of Wellhead Protection Program with Other State and Federal Ground Water Programs

There are several other programs in Washington that complement, but do not replace local wellhead protection programs. These include the Aquifer Protection Area Program, the Ground Water Management Area Program, the Critical Aquifer Recharge Area Program, the Sole Source Aquifer Program, Special Protection Area designation, the State Environmental Policy Act and the Water System Coordination Act.

Aquifer Protection Area Program

Aquifer Protection Areas and Aquifer Protection Districts were established in RCW 36.36. This allows counties legislative authority to designate an aquifer protection area and propose a ballot measure to impose a monthly fee on water withdrawals or on-site sewage disposal for a specific number of years. The monies generated could be used for a variety of ground water programs, including wellhead protection. A major value of this mechanism is that it allows local governments to establish a stable funding base for wellhead protection implementation efforts.

Ground Water Management Area Program

The Ground Water Management Area (GWMA) program was established by the state legislature in 1985 and is described in WAC Chapter 173-100. The GWMA program is a regional level program for managing the ground water resource. A GWMA is a specific geographic area which encloses one or more aquifers and in which there exists a justifiable concern for the quality or quantity of the ground water. The purposes of designating a GWMA are to:

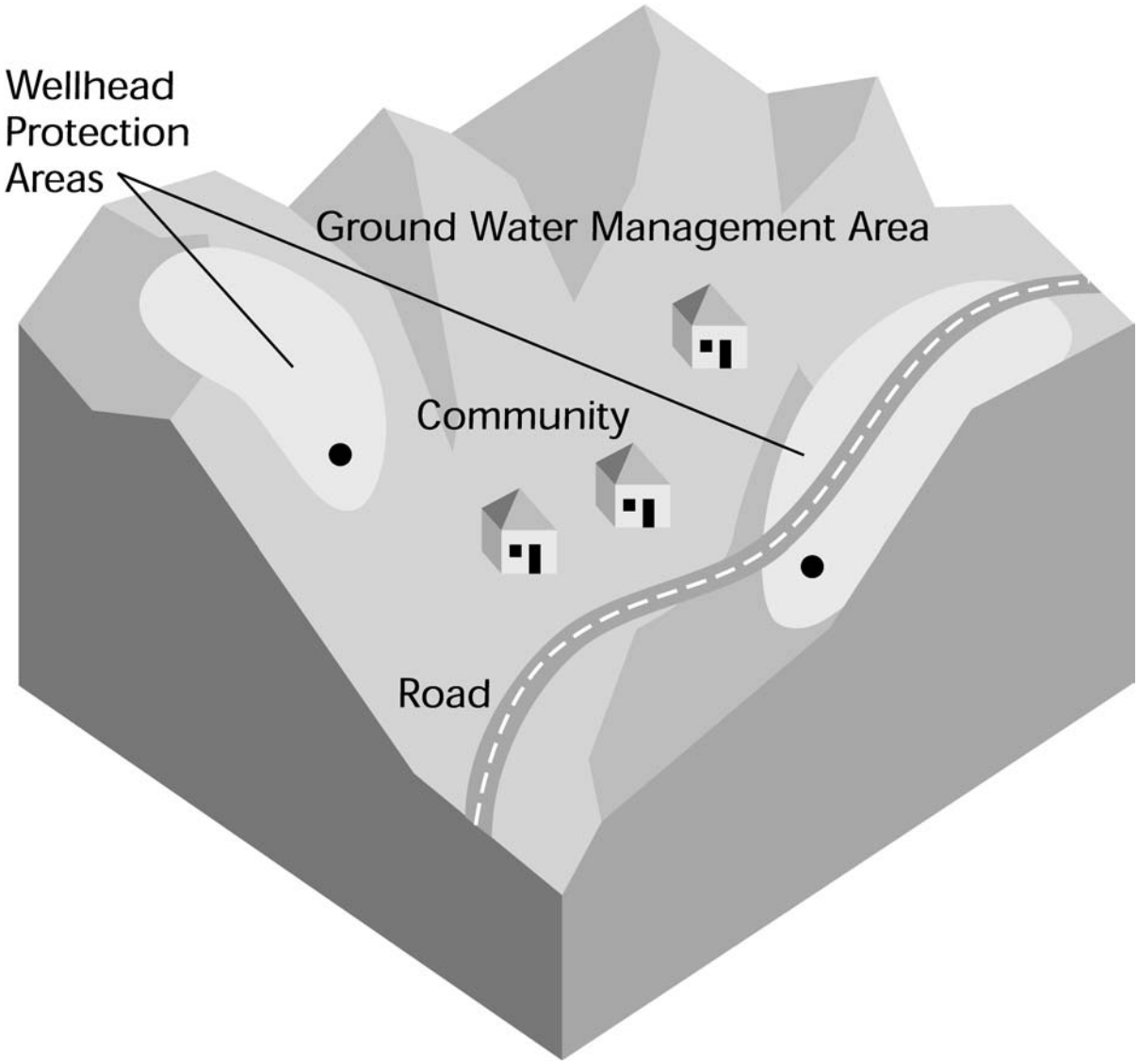
1. Protect the quality and quantity of ground water,
2. Meet future water needs while recognizing existing water rights, and
3. Provide for effective and coordinated management of the ground water resource.

GWMAs and wellhead protection areas are complementary but have distinct differences (**Figure 9**). GWMAs cover a large area (county or subcounty level) and consider all beneficial uses-not just drinking water supplies. Wellhead protection is often an integral part of the implementation plan of a GWMA, but is not a required component. For more details on the GWMA program, contact the Department of Ecology's Water Resources Program (Appendix C).

Critical Aquifer Recharge Areas and the Growth Management Act

Local jurisdictions planning under the Growth Management Act (GMA) are required to identify Critical Aquifer Recharge Areas (CARAs). The GMA requires all counties/cities to classify, designate, and regulate to protect "areas with a critical recharging effect on aquifers used for potable waters."

Figure 8. Wellhead Protection Areas and Ground Water Management Areas



Wellhead protection areas meet the definition of critical aquifer recharge areas. A local wellhead protection program can serve as a mechanism to protect critical aquifer recharge areas. The converse is also true: declaration of a wellhead protection area as a critical aquifer recharge area is a useful component of a local wellhead protection program. This is due, in part, to the GMA requirement that jurisdictions develop local regulations and policies to protect critical areas. In addition, there is an interjurisdictional planning mechanism provided through the GMA to work on the protection of critical areas which cross jurisdictional borders. This can be an important consideration for municipal wellhead protection areas that extend outside of the purveyor's jurisdictional boundaries. CARA designation may also be used for protecting noncontiguous buffer zones. CARA designation under the GMA can provide important protection for the long-term quality, and quantity, of public water supplies.

All wellhead protection areas are not necessarily equal; this should be taken into account by local governments considering the use of critical area designations to protect wellhead protection areas. Local jurisdictions may wish to define the criteria they will use to evaluate the significance of specific wellhead protection areas. Possible criteria include: number of connections, system ownership (municipal vs. private), susceptibility of the source water to contamination and irreplaceability of the source.

For more information on CARAs, contact the Department of Community Trade and Economic Development (Appendix C).

Sole Source Aquifer Program

The Sole Source Aquifer program is a federal program. A Sole Source Aquifer (SSA) is an aquifer designated by EPA as the "sole or principle source" of drinking water for a given aquifer service area; that is, an aquifer which is needed to supply 50% or more of the drinking water for that area and for which there are no reasonably available alternative sources should the aquifer become contaminated.

A primary benefit of SSA designation is that proposed federal financially assisted projects which have the potential to contaminate the SSA area will be subject to EPA review. This review could either prevent a commitment of federal funding or cause a redesign of the project. Designation has no effect on proposed projects which do not receive federal financial assistance such as projects funded by state, local, or private entities.

At least three additional benefits stem from SSA designation. The first is the increased public awareness of the source of the community's drinking water, with an increased willingness to protect it. Second, SSA designation may enhance a local government's ability to receive state grants through the CCWF. Third, EPA assembles available hydrogeologic information on designated aquifers into technical support summaries.

EPA has a long-standing policy of not initiating SSA designations. Instead, EPA responds to an application or "petition" which requests designation. This means that EPA designations are limited to those geographic areas where an individual or organization has documented the hydrogeologic boundaries and drinking water dependency of a sole source aquifer and has submitted this information to EPA in a formal request. EPA designations do not consider either an area's hydrogeologic susceptibility or potential for ground water contamination.

The value of an effective local wellhead protection program is clear within a SSA area. If the irreplaceability of the ground water resource has already been recognized, the desire to protect its quality should be high.

Contact EPA Region X's Ground Water Section for more information on the SSA program (Appendix C).

Special Protection Areas

WAC Chapter 173-200, Water Quality Standards for Ground Waters, provides for the designation of Special Protection Areas that require special consideration or protection due to unique or vulnerable characteristics. These characteristics include critical recharge areas and wellhead protection areas. Designation of a vulnerable wellhead protection area as a Special Protection Area may result in stricter discharge limits placed on state waste discharge permits, and/or increased outreach, regulatory inspections and enforcement actions.

Information on Special Protection Areas can be obtained by contacting the Ground Water Quality Unit of the Department of Ecology (Appendix C).

State Environmental Policy Act

Environmentally Sensitive Areas (ESAs) can be designated by a local government under authorities provided by the State Environmental Policy Act (SEPA, WAC 197-11 and related local authorities). This designation can provide additional protection to specific areas such as vulnerable wellhead protection areas than would be accomplished under standard SEPA guidelines. This additional protection occurs because categorical exemptions can be modified. The ESA designation can impact underground storage tanks, facilities affecting stormwater, and other potential sources of ground water contamination.

Information on SEPA and ESAs can be obtained from Ecology's Environmental Review/Sediment Management Section (Appendix C).

Water System Coordination Act

The Water System Coordination Act (WAC 246-293) provides a process to assure coordinated regional planning for public water systems within defined Critical Water Supply Service Areas. A primary objective of the law is to integrate water system development with land use planning in a give area so as to minimize conflicts between land use and water system plans. An early activity in this regional planning process is establishment of a Water Utility Coordinating Committee. The Committee's purpose is to organize a local partnership between county legislative authority, county planning agency, county health agency, water purveyors, and DOH to develop and implement workable solutions to water system problems. Other interested agencies, organizations or individuals may also participate in the Committee.

12. Public Participation in State Plan Development, Public Outreach and Educational Efforts

Wellhead Policy and Technical Advisory Committees

The proposed Wellhead Protection Program presented here was developed by DOH, with valuable input from a variety of sources. First and foremost are the members of the Wellhead Protection Policy Advisory Committee and the Wellhead Protection Technical Advisory Committee. Members of both committees worked extremely hard to attend meetings-often spending several hours in travel status as a result. They provided valuable feedback as the state program took form-verbally at meetings, in subsequent phone conversations, and in writing.

Although the individuals on the committees were chosen as representatives from various agencies and organizations, the views expressed by members were not necessarily interpreted as representing the views of their organizations. The presence of staff from a given organization on an advisory committee does not necessarily constitute an endorsement of the proposed program.

Members of the Wellhead Protection Policy Advisory Committee include:

Mr. Dale Arnold	Environmental Programs Dept., City of Spokane
Mr. Bert Bowen	WA Dept. of Ecology, Ground Water Quality Unit
Ms. Doris Cellarius	Sierra Club
Mr. Stephen Deem	WA Dept. of Health, NW Regional Office
Ms. Anne Dickerson	League of Women Voters
Mr. Scott Downey	US EPA, Office of Ground Water
Mr. Lee Faulconer	WA Dept. of Agriculture
Mr. Russell Fox	The Evergreen State College
Mr. Jack Henderson	City of Newport
Ms. Jackie Hightower	Association of WA Counties
Ms. Jannine Jennings	Yakima Indian Nation
Mr. David Jones	Public Utility District #1, Kitsap County
Mr. Mike Krautkramer	WA State Drilling & GW Association
Mr. Bill Lasby	Seattle-King County Health Department
Mr. Rex L. Lyle	WA State Water Resources Association
Mr. Bruce McKnight	WA State Water/ Wastewater Association
Mr. Ronald L. Olson	Utility Engineering/ City of Renton
Ms. Lisa Raysby	WA State Dept. of Health, SW Regional Office
Ms. Trudy Rolla	Seattle-King County Health Department

Mr. Earl Rowell	IRC / Clark County Water Quality Division
Mr. Derek Sandison	Adolfson Assoc. Inc.
Mr. Dave Siburg	Public Utility District #1, Kitsap County
Mr. Jay Smith	Washington Rural Water Association
Ms. Betty Tabbutt	Washington Environmental Council
Mr. Tom Waltz	Clark County Neighbors Association
Mr. Tom Wells	WA Dept. of Health, Eastern Regional Office
Mr. Ron Wiley	WA State Drilling & GW Association

Members of the Wellhead Protection Technical Advisory Committee are:

Mr. Denis Erickson	WA Department of Ecology
Dr. Kent Keller	Dept. of Geology, WSU
Mr. Bill Lum	U.S. Geological Survey
Mr. Dan Matlock	Pacific Groundwater Group
Mr. Stan Miller	Spokane County Public Works
Mr. Tom Ring	Yakima Indian Nation
Ms. Martha Sabol	Office of Ground Water, EPA
Ms. Ginny Stern	WA State Dept. of Health
Mr. Rod Swanson	IRC/ Clark County Water Quality Division
Ms. Lisa Dally Wilson	Dally Environmental

Additional Public Input into State Plan Development

DOH solicited additional public and agency input into development of Washington's Wellhead Protection Program. From July 1992 through December 1992, approximately 35 presentations on Washington's proposed wellhead protection program were made across the state. Targeted audiences included water system purveyors, local government officials, other state and federal agencies and programs, and the general public. During presentations, feedback was sought from the audience on how to improve the program, and to identify significant gaps.

Public Outreach and Educational Efforts

DOH functions as the primary contact agency for individuals, organizations, and municipalities seeking information on the state Wellhead Protection Program. Staff from both the Wellhead Protection Office and DOH's Regional Offices are available to make presentations on the state wellhead protection program, participate in interjurisdictional or multi-purveyor wellhead protection implementation meetings and/or take other steps as appropriate to help implement local wellhead protection programs. A primary objective of DOH is to educate water system

purveyors, interested citizens, agency staff and elected officials on the importance of wellhead protection in Washington State.

DOH has primary responsibility for publicizing the State's Wellhead Protection Program, although all of Washington's agencies assume some responsibility for informing potentially affected communities and/or parties. DOH will notify existing purveyors of the requirements of the program. Ecology, due to its responsibilities for issuing well drilling permits, state waste discharge permits and similar regulatory actions, will distribute wellhead protection program information to appropriate applicants.

Wellhead Protection Workshops

DOH, in conjunction with EPA Region X, the Washington Rural Water Association, and the Pacific Northwest Section (and local subsections) of the American Water Works Association, has been holding 1 and 2-day wellhead protection workshops across the state. For information on future workshops, please contact DOH's Wellhead Protection Office.

Prior Versions of the Wellhead Protection Guidance Document

DOH released the *Draft Washington State Proposed Wellhead Protection Program* document for public review and comment in June of 1993. Written comments on the proposed program were accepted until the end of business on August 31, 1993. A public hearing on the proposed program was held in Bellevue on August 26, 1993.

Written comments were received from the Seattle/King County Department of Public Health, the Clallam County Department of Community Development, the Washington State Water Resources Association, the City of Spokane, and Converse Consultants NW. Oral comments were received at the public hearing from the City of Renton.

Based on comments received, and to complement the proposed WAC language, a revised version of the guidance document was release in December of 1993. All 2,000 copies printed were distributed during 1994 and early 1995. The current version, dated April 1995, contains some changes from the December 1993 version. These changes were made to clarify approaches to issues which have arisen during the first months of program implementation, update changes in names of agencies and programs, and correct typographical errors.

Glossary

Aquifer—rock or sediment formation capable of storing, transmitting, and yielding water to wells.

Best Management Practices (BMPs)—practices and operating procedures which aid in the prevention or reduction of the pollution load. They are designed to facilitate voluntary compliance through education.

Ground Water—subsurface water found in the zone of saturation.

Group A Public Water System—a water system in Washington State which meets the federal definition of a public water system. This is a water system with ten or more connections, or which serves an average of twenty-five or more persons per day for sixty or more days within a calendar year. WAC 246-290-020.

Hydrogeology—refers to the study of ground water with emphasis on its interaction with geologic materials and settings.

Initial Inventory—an inventory done during the source approval process. The inventory must, at a minimum, identify all potential and actual sources of ground water contamination that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring, or wellfield within the 1-year time of travel zone, and all high-risk sources within the entire wellhead protection area.

Injection Well—a well used to dispose of fluids underground. Fluids enter either by gravity flow or by injection under pressure.

Nonpoint Source—a source discharging pollutants into the environment that is not a single, discrete point.

Point Source—any discernible, confined, or discrete conveyance from which pollutants are or may be discharged, including, (but not limited to) pipes, ditches, channels, tunnels, conduits, wells, containers, rolling stock, concentrated animal feeding operations, or vessels.

Preliminary Delineation—a wellhead protection area delineation done during source approval. Calculated fixed radius method can be used, screened area estimated, and pumping rate based on either water right quantity or number of connections.

Public Water System—defined in Washington State as any system, excluding systems serving only one single-family residence, providing piped water for human consumption.

Recharge Area—area in which water reaches the zone of saturation by surface infiltration.

Time of Travel (TOT)—the time period used to define the area through which ground water will move and recharge a pumping well. For wellhead protection purposes, TOT is expressed in years.

Water Table—upper surface of a zone of saturation, where the body of ground water is not confined by an overlying impermeable zone.

Wellfield—an area containing two or more wells with overlapping zones of contribution that supply a public water system.

Wellhead—the physical structure, facility, or device at the land surface from or through which ground water flows or is pumped from water-bearing formations.

Wellhead Protection Area—the surface and subsurface area surrounding a water well, or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach the water well or wellfield.

Zone of Saturation—that part of the earth's crust beneath the regional water table in which all voids, large and small, are filled with water under pressure greater than atmospheric.

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Appendix A-1
Section 1428 of the 1986 Amendments to the Safe Drinking Water Act

Sec. 1428. State Programs to Establish Wellhead Protection Areas

(a) State Programs—The Governor or Governor's designee of each State shall, within 3 years of the date of enactment of the Safe Drinking Water Act Amendments of 1986, adopt and submit to the Administrator a State program to protect wellhead areas within their jurisdiction from contaminant which may have any adverse affect on the health of persons. Each State program under this section shall, at a minimum:

(1) specify the duties of State agencies, local governmental entities, and public water supply systems with respect to the development and implementation of programs required by this section;

(2) for each wellhead, determine the wellhead protection area as defined in subsection (e) based on all reasonable available hydrogeologic information on ground water flow, recharge and discharge and other information the State deems necessary to adequately determine the wellhead protection area;

(3) identify within each wellhead protection area all potential anthropogenic sources of contaminants which may have any adverse effect on the health of persons;

(4) describe a program that contains, as appropriate, technical assistance, financial assistance, implementation of control measures, education, training, and demonstration projects to protect the water supply within wellhead protection areas from such contaminants;

(5) include contingency plans for the location and provision of alternate drinking water supplies for each public water system in the event of well or wellfield contamination by such contaminants; and

(6) include a requirement that consideration be given to all potential sources of such contaminants within the expected wellhead area of a new water well which serves a public water supply system.

(b) Public Participation—To the maximum extent possible, each State shall establish procedures, including but not limited to, the establishment of technical and citizens' advisory committees, to encourage the public to participate in developing the protection program for wellhead areas. Such procedures shall include notice and opportunity for public hearing on the State program before it is submitted to the Administrator.

(c) Disapproval—

(1) In General—If, in the judgment of the Administrator, a State program (or portion thereof, including the definition of a wellhead protection area), is not adequate to protect public water systems as required by this section, the Administrator shall disapprove such program (or portion thereof). A State program developed pursuant to subsection (a) shall be deemed to be adequate unless the Administrator determines, within 9 months of the receipt of a State program, that such program (or portion thereof) is inadequate for the purpose of protecting public water systems as required by this section from contaminant that may have any adverse effect on the health of persons. If the Administrator determines that a proposed State program (or any portion thereof) is inadequate, the Administrator shall submit a written statement of the reasons for such determination to the Governor of the State.

(2) Modification and Resubmission—Within 6 moths after receipt of the Administrator's written notice under paragraph (1) that any proposed State program (or portion thereof) is inadequate, the Governor or Governor's designee, shall modify the program based upon the recommendations of the Administrator and resubmit the modified program to the Administrator.

(d) Federal Assistance—After the date, 3 years after the enactment of this section, no State shall receive funds authorized to be appropriated under this section except for the purpose of implementing the program and requirements of paragraphs (4) and (6) of subsection (a).

(e) Definition of Wellhead Protection Area—As used in this section, the term "wellhead protection area" means the surface and subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield. The extent of a wellhead protection area, within a State, necessary to provide protection from contaminants which may have an adverse effect on the health of persons is to be determined by the State in the program submitted under subsection (a). Not later than one year after the enactment of the Safe Drinking Water Act Amendments of 1986, the Administrator shall issue technical guidance which States may use in making such determinations. Such guidance may reflect such factors as the radius of influence around a well or wellfield, the depth of drawdown of the water table by such well or wellfield at any given point, the time or rate of travel of various contaminants in various hydrologic conditions, distance from the well or wellfield, or other factors affecting the likelihood of contaminants reaching the well or wellfield, taking into account available engineering pump tests or comparable data, filed reconnaissance, topographic information, and the geology of the formation in which the well wellfield is located.

(f) Prohibitions—

(1) Activities Under Other Laws—No funds authorized to be appropriated under this section may be used to support activities authorized by the Federal Water Pollution Control Act, the Solid Waste Disposal Act, the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, or other sections of this Act.

(2) Individual Sources—No funds authorized to be appropriated under this section may be used to bring individual sources of contamination into compliance.

(g) Implementation—Each State shall make every reasonable effort to implement the State wellhead area protection program under this section within 2 years of submitting the program to the Administrator. Each State shall submit to the Administrator a biennial status report describing the State's progress in implementing the program. Such reports shall include amendments to the State program for water wells sited during the biennial period.

(h) Federal Agencies—Each department, agency, and instrumentality of the executive, legislative, and judicial branches of the Federal Government having jurisdiction over any potential source of contaminants identified by a State program pursuant to the provisions of subsection (a)(3) shall be subject to and comply with all requirements of the State program developed according to subsection (a)(4) applicable to such potential source of contaminants, both substantive and procedural, in the same manner, and to the same extent as any other person is subject to such requirements, including payment of reasonable charges and fees. The President may exempt any potential source under the jurisdiction of any department, agency, or instrumentality in the executive branch if the President determines it to be in the paramount interest of the United States to do so. No such exemption shall be granted due to the lack of an appropriation as part of the budgetary process and the Congress shall have failed to make available such requested appropriations.

(i) Additional Requirement—

(1) In General—In addition to the provisions of subsection (a) of this section, States in which there are more than 2,500 active wells at which annular injection is used as of January 1, 1986, shall include in their State program a certification that a State program exists and is being adequately enforced that provides protection from contaminants which may have any adverse effect on the health of persons and which are associated with the annular injection or surface disposal of brines associated with oil and gas production.

(2) Definition—For purposes of this subsection, the term "annular injection" means the reinjection of brines associated with the production of oil or gas between the production and surface casings of a conventional oil or gas producing well.

(3) Review—The Administrator shall conduct a review of each program certified under this subsection.

(4) Disapproval—If a State fails to include the certification required by this subsection or if in the judgment of the Administrator the State program certified under this subsection is not being adequately enforced, the Administrator shall disapprove the State program submitted under subsection (a) of this section.

(j) Coordination with Other Laws—Nothing in this section shall authorize or require any department, agency, or other instrumentality of the Federal Government or State or local government or apportion, allocate or otherwise regulate the withdrawal or beneficial use of ground or surface water, so as to abrogate or modify any existing rights to water established pursuant to State or Federal law, including interstate compacts.

Appendix A-2
Wellhead Protection Related Excerpts from WAC Chapter 246-290 (adopted July 1994) Group A Public Water Systems

The Department of Health prepared this extract from the Code Reviser's official copy.

A complete copy of WAC Chapter 246-290 can be obtained by contacting your DOH Division of Drinking Water Regional Office or by calling 1-800-521-0323.

WAC Number	Heading
General Provisions	
246-290-10	Definitions
Planning and Engineering Documents	
246-290-130	Source Approval
246-290-135	Source Protection
246-290-140	Existing System Approval
246-290-410	Small Water System Management Program

WAC 246-290-010 Definitions:

Abbreviations:

GWI – ground water under the direct influence of surface water;

SOC – synthetic organic chemical;

VOC – volatile organic chemical;

WFI – water facilities inventory and report form; and

WHPA – wellhead protection area.

"Contingency plan" means that portion of the wellhead protection program section of the water system plan or small water system management program that addresses the replacement of the major well(s) or wellfield in the event of loss due to ground water contamination.

"Ground water under the direct influence of surface water (GWI)" means any water beneath the surface of the ground that the department determines has the following characteristics: Significant occurrence of insects or other macroorganisms, algae, or large-diameter pathogens such as *Giardia lamblia*; or Significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH closely correlating to climatological or surface water conditions.

"Guideline" means a department document assisting the purveyor in meeting a rule requirement.

"Initial Inventory" means an inventory which consists, at a minimum, of all potential sources of ground water contamination located within the one-year time of travel area of a WHPA and all high-risk potential sources of ground water contamination located within the ten-year ground water time of travel area.

"Monitoring waiver" means an action taken by the department under WAC 246-290- 300 (4)(g) or (7)(f) to allow a water system to reduce specific monitoring requirements based on a determination of low source vulnerability to contamination. Guidance on applying for monitoring waivers is found in the department guideline titled, "Source Vulnerability and Monitoring Waivers" which is available from the department.

"Protected ground water source" means a ground water source the purveyor shows to the department's satisfaction as protected from potential sources of contamination on the basis of hydrogeologic data and/or satisfactory water quality history.

"Public water system" is defined and referenced under WAC 246-290-020.

"Purveyor" means an agency, subdivision of the state, municipal corporation, firm, company, mutual or cooperative association, institution, partnership, or person or other entity owning or operating a public water system. Purveyor also means the authorized agents of such entities.

"Susceptibility assessment" means the completed Susceptibility Assessment Survey Form developed by the department to evaluate the hydrologic setting of the water source and assess its contribution to the source's overall susceptibility to contamination from surface activities.

"Synthetic organic chemical (SOC)" means a manufactured carbon-based chemical.

"Time-of-travel" means the time required for ground water to move through the water bearing zone from a specific point to a well.

"Watershed" means the region or area which:
Ultimately drains into a surface water source diverted for drinking water supply; and affects the physical, chemical, microbiological, and radiological quality of the source.

"Well field" means a group of wells one purveyor owns or controls that:
Draw from the same aquifer or aquifers as determined by comparable inorganic chemical analysis and comparable static water level and top of the open interval elevations; and Discharge water through a common pipe and the common pipe shall allow for collection of a single sample before the first distribution system connection.

"Wellhead protection area (WHPA)" means the portion of a well's, wellfield's or spring's zone of contribution defined as such using WHPA criteria established by the department.

"Zone of contribution" means the area surrounding a pumping well or spring that encompasses all areas or features that supply ground water recharge to the well or spring.

WAC 246-290-130 Source Approval.

(1) No new source, previously unapproved source, or modification of an existing source shall be used as a public water supply without department approval.

(2) A party seeking approval shall provide the department:

(e) For wells and springs:

(i) A susceptibility assessment;

(ii) A preliminary WHPA designation using the calculated fixed radius method, with six month, one, five, and ten year time of travel criteria; and

(iii) An initial inventory of potential sources of ground water contamination located within the WHPA.

(l) A copy of the water well report including the Washington well identification number, depth to open interval or top of screened interval, overall depth of well, and location (both plat location and latitude/longitude);

(o) Well source development data establishing the capacity of the source. Data shall include:

(i) Static water level;

(ii) Wellhead elevation;

(iii) Yield;

(iv) The amount of drawdown;

(v) Recovery rate;

(vi) Duration of pumping; and

(vii) Interference between existing sources and the source being tested.

WAC 246-290-135 Source Protection.

(1) The purveyor shall obtain drinking water from the highest quality source feasible. Existing and proposed sources of supply shall conform to the water quality standards established in WAC 246-290-310.

(2) The department may require monitoring and controls in addition to those specified in this section if, in the opinion of the department, a potential risk exists to the water quality of a source.

(4) Wellhead protection.

(a) Purveyors of water systems using ground water or spring sources shall develop and implement a wellhead protection program.

(b) The wellhead protection program shall be part of the water system plan required under WAC 246-290-100 or the small water system management program required under WAC 246-290-410.

(c) The purveyor's wellhead protection program shall contain, at a minimum, the following elements:

(i) A completed susceptibility assessment or equivalent information;

(ii) WHPA delineation for each well, wellfield, or spring with the one, five and ten year time of travel boundaries marked, or boundaries established using alternate criteria approved by the department in those settings where ground water time of travel is not a reasonable delineation criteria. WHPA delineations shall be done in accordance with recognized methods such as those described in the following sources:

(I) Washington State Wellhead Protection Program;

or

(II) EPA Guidelines for Delineation of Wellhead Protection Areas, EPA 440/6-87-010;

(iii) A list of all actual and potential ground water contaminant sources located within the defined WHPA(s). This list shall be updated every two years;

(iv) Documentation of purveyor's notification to all owners/operators of actual and potential sources of ground water contamination within the WHPA boundaries;

(v) Documentation of purveyor's notification to regulatory agencies and local governments of the boundaries of the WHPA(s) and the finding of the WHPA boundaries;

(vi) A contingency plan to ensure consumers have an adequate supply of potable water in the event that contamination results in the temporary or permanent loss of the principal source of supply (major well(s) or wellfield); and

(vii) Documentation of coordination with local emergency spill responders (including police, fire and health departments), including notification of WHPA boundaries, results of susceptibility assessment, inventory findings, and contingency plan.

Sections in the department guidelines titled *Planning Handbook, Washington State Wellhead Protection Program,* and *Inventory of Potential Sources of Ground Water Contamination in Washington's Wellhead Protection Areas* address wellhead protection in more detail, and are available to purveyors establishing local wellhead protection programs.

WAC 246-290-140 Existing System Approval.

(1) When applying for approval, purveyors of existing public water systems without approved construction documents shall provide department-determined information.

(2) Information provided shall be consistent with WAC 246-290.

(3) Purveyors shall contact the department to obtain a list of specific requirements including, for wells and springs:

(a) A susceptibility assessment;

(b) A preliminary WHPA designation using the calculated fixed radius method, with six month, one, five, and ten year time of travel criteria; and

(c) An initial inventory of potential sources of ground water contamination located within the WHPA.

WAC 246-290-410 Small Water System Management Program.

(1) The purpose of small water system management program is to assure the water system:

(a) Is properly and reliably managed and operated, and

(b) Continues to exist as a functional and viable entity.

(2) A small water system management program shall be developed and implemented for all systems not required to complete a water system plan as described under WAC 246-290-100.

(4) Department guidelines titled Planning Handbook and The Washington State Wellhead Protection Program are available to assist the purveyor in establishing the level of detail and content of the management program. Content and detail shall be consistent with the size, complexity, past performance and use of the public water system. General content topics shall include, but not be limited to, the following elements;

(a) Ownership and decision-making issues;

(b) Financial viability;

(c) Operations;

(d) Source protection, including a watershed control program or wellhead protection program when applicable under WAC 246-290-135; and

(e) Conservation.

Appendix B-1
Checklist of required wellhead protection elements

Wellhead Protection Requirements

The 1986 amendments to the Federal Safe Drinking Water Act require that all states establish a Wellhead Protection Program. The Washington State Wellhead Protection Program was officially adopted in July of 1994.

All Group A public water systems in the state using wells or springs (excluding systems using purchased sources, or interties) are required to develop a wellhead protection program. The goal of the program is to prevent contamination of ground water used for drinking water. The strategy used to accomplish this goal involves three main components:

- Delineation of wellhead protection areas,
- Inventory of potential contaminant sources, and
- Management of wellhead protection areas to prevent contamination.

Each purveyor's wellhead protection plan will be incorporated into either their Water System Plan or Small Water System Management Program document.

What follows is a brief description of the State's Wellhead Protection Program and the requirements for each component as they should appear in your wellhead protection plan. A checklist, located on page 94, reviews all the required program components.

Overview

As part of your wellhead protection plan, include a brief overview of how your program has been developed and implemented. Present relevant information such as your coordination with other purveyors or local agencies, and whether or not you established a wellhead protection committee. The information included will help DOH staff evaluate how effective your implementation efforts are, and assist us in reviewing the documentation you submit.

Delineation

A wellhead protection area is the area managed by a community (or private water association, homeowner's association, etc.) to protect its ground water based drinking water supplies. If, for example, a spill of hazardous materials occurred in this area, it could pose a direct risk to your drinking water supply.

Wellhead protection areas may consist of four or five zones: the standard sanitary control area, three additional zones based on the one, five, and ten-year time of travel rates, and, where appropriate, a larger buffer zone.

The methods used for identifying the wellhead protection area will vary depending on the susceptibility of the well (determined by the Susceptibility Assessment Form), and the size of the water system. **A completed Susceptibility Assessment, or documentation that one has already been submitted to DOH, must be included as part of the wellhead protection program.** A discussion of the susceptibility ranking of your system, the meaning of that determination, and the number of persons served by your system should be included in all notification letters (e.g. delineation boundaries, inventory findings, and spill response).

Timeline: The initial wellhead protection area boundaries must be established within one year of program adoption (deadline: July 1995). However, systems with greater than 1,000 connections determined to be hydrogeologically susceptible **and** those who choose to delineate using analytical or other site-specific methods, will have 2 years to complete their delineations (deadline: July 1996).

Delineation Requirements

The wellhead protection area boundaries should be plotted on a base map that shows major landmarks and topography, with a scale large enough to adequately display the delineated areas. A map with a scale of three to four inches per mile would be highly desirable. If you are unable to located a map of this scale, a 7 ½ minute U.S. Geological Survey topographic map would be appropriate to use, **if enlarged by photocopying**. Prior to enlarging, draw a 1 mile bar of the correct scale on the map. Please ensure that the wellhead protection area boundaries on the map are drawn to scale as well.

You must notify local decision makers (both elected officials and planning/regulatory agencies) of the wellhead protection area boundaries. Examples of entities to notify include: your local planning and health departments, county commissioners, and public works programs. This notification should be documented in the wellhead protection portion of your water system plan. A discussion of the susceptibility ranking of your system, the meaning of that determination and the number of persons served by your system should be included.

PWSs with less than 1,000 connections:

1. If the source of supply is determined to be of low to moderate susceptibility, you can use the Calculated Fixed Radius method to delineate the 1, 5, and 10-year time of travel zones. You should consider using a more sophisticated delineation method within 5 years.

2. If the source of supply is determined to be of high susceptibility, you can use the Calculated Fixed Radius method to delineate the 1, 5, and 10-year time of travel zones. However, this **should be upgraded** to a more sophisticated, site-specific method within 5 years.

PWSs with 1,000 or more connections:

1. If the source of supply is determined to be of low to moderate susceptibility, you can use the Calculated Fixed Radius method to initially delineate the 1, 5, and 10-year time of travel zones. However, this **should be upgraded** to a more sophisticated, site-specific method within 5 years.

2. If the source of supply is determined to be of high susceptibility, you should us an analytical or other sophisticated, site-specific method (i.e. semi-analytical, numerical and/or hydrogeologic mapping) by July of 1996.

If the Calculated Fixed Radius method is used, the following must be included:
1. Map of wellhead protection area delineations at the appropriate scale,
2. Screened interval of the well (or statement that well is of open hole construction),
3. Pumping rate of the well,
4. An example of the notification letter used, and
5. A listing of those notified of the wellhead protection area boundaries.

If a more site-specific method is used, the following must be included:
1. Map of wellhead protection area delineations at the appropriate scale,
2. Explanation of methodology used,
3. An example of the notification letter used, and
4. A listing of those notified of the wellhead protection area boundaries.

Inventory

Purveyors are required to conduct an inventory of potential contaminant sources in their wellhead protection areas. The purpose of the inventory is to identify past (the last 10-20 years), present and proposed activities or land uses that may pose a threat to the water bearing zone (aquifer) utilized by the well, spring, or wellfield.

The list of potential contaminant sources is long, but includes improperly abandoned wells, the use of fertilizers and pesticides, and facilities such as gas stations and dry cleaners. For more detailed information about the inventory process, the DOH document *"Inventory of Potential Contaminant Sources in Washington's Wellhead Protection Area"* is available from your DOH regional office.

Completing this inventory, along with a Susceptibility Assessment Form, may also allow you to apply for a use waiver for the Phase II/Phase V regulated compounds.

Once you have identified potential threats to your drinking water supply through the inventory, there is a need to prioritize these potential contaminant sources. Interpretation of the inventory information should include some type of hazard ranking system relative to ground water contamination and the possible impact on your system's source of drinking water.

Timeline: An inventory must be completed within one year of wellhead protection area delineation (deadline: July 1996 if Calculated Fixed Radius delineation used, July 1997 if more site-specific method is used). It must be updated every two years, more often if growth or changes in land use are significant.

Inventory Requirements

The following must be included in the wellhead protection plan:

1. A list of all potential and known sources of ground water contamination (past and present) within the wellhead protection area boundaries, which could threaten the source water. The inventory findings should be prioritized and grouped by time of travel zones. This list is required by WAC to be updated at least every two years.

2. Documentation that the purveyor has notified the correct regulatory agencies and local governments of the location of potential and known sources of ground water contamination within the wellhead protection area boundaries. An example notification letter should be included, along with a list of those notified.

3. Documentation that the purveyor has notified all owners/operators of known and potential sources of ground water contamination of their location within the wellhead protection area boundaries. An example notification letter should be included, along with a list of those notified.

Highly susceptible systems with 1,000 or more connections should also include:

1. Current land use/zoning designation of the wellhead protection area(s),

2. A priority ranking of potential contaminant sources (high to low).

Management

Without implementing management strategies to prevent **potential** contaminant sources from becoming **actual** sources of ground water contamination, wellhead protection planning accomplishes little. Since many purveyors do not own or control all of the land that falls within their wellhead protection areas, an effective wellhead protection program must have the cooperation of those who do have control (i.e. local government agencies, land owners). A key stop in managing the wellhead protection area is accomplished through the inventory requirement of notification of owners/operators and regulatory agencies regarding the location of potential contaminant sources.

Public education is a very important part of managing wellhead protection areas. Once people understand that their activities might affect the water they drink, they are more willing to change their practices.

An effective way to involve the public in the program is to form a local wellhead protection committee. Members of the committee can include representatives of jurisdictions with land use controls over the wellhead protection area; water system purveyors; members of industrial, commercial, and agricultural organizations; citizen action groups, tribal representatives and regulatory agency personnel. By involving members of affected groups from the beginning, it is more likely that your wellhead protection plan will become an accepted, effective, implementable program.

There are two components of managing the wellhead protection area that purveyors are required to undertake:

1. **Contingency plans** for an alternative supply of water should the primary well or wellfield be lost due to contamination and;

2. **Emergency spill / incident response coordination.**

Timeline: Spill / incident response coordination and contingency plans need to be completed within one year of wellhead protection area delineation (July 1996 if the Calculated Fixed Radius method was used, July 1997 if a more site-specific method was used).

Management Requirements

The wellhead protection plan should document that the system has:

1. A **contingency plan** to ensure consumers have an adequate supply of potable water in the event that contamination results in the temporary or permanent loss of the principal source of supply (major well(s) or wellfield). At a minimum, the contingency plan should:

    - Identify maximum water system capacity in relation to source, distribution system, and water rights restrictions. Assume loss of largest well/wellfield and reevaluate;

    - Identify existing or potential interties with other public water systems and evaluate the ability to deliver water assuming loss of largest well/wellfield, include costs associated with the purchase and/or delivery of alternate supplies; and

    - Identify future potential sources of drinking water and describe quality assurances and control methods to be applied to ensure protection of water quality prior to utilization as a drinking water supply.

Costs associated with obtaining alternative sources of supply, in both the short and long term, should be estimated within the contingency plan section. In the event that analysis shows no alternative sources of supply or interties are available, the contingency plan should clearly state this and proceed to analyze treatment options for the potential contaminant sources determined to pose the highest risk to the source of supply.

2. An **emergency spill / incident response program.** You must provide a copy of the wellhead protection area boundaries, results of the susceptibility assessment, inventory findings, and contingency plans to local emergency responders (e.g. police, fire departments), and the local health department, and any local emergency planning committee. They can then evaluate whether changes in spill / incident response measures are needed to better protect ground water / drinking water quality within the wellhead protection area.

Wellhead Protection and the Waiver Process

Group A systems that actively seek monitoring waivers for the Phase II/V regulated compounds are well on their way to also fulfilling the regulatory requirements of wellhead protection. Susceptibility assessments, wellhead protection area boundary establishment, and inventory of contaminant sources are principle elements of both programs. Once steps are taken to seek monitoring waivers, implementing the additional steps required under the wellhead protection program helps ensure that future monitoring waivers may be more easily granted by the department. With an on-going program to prevent the contamination of your well or wellfield, you will be able to demonstrate that the system's drinking water is at a lowered risk of contamination and may reduce future monitoring requirements.

Wellhead Protection Checklist

Have you included:

SUSCEPTIBILITY ASSESSMENT

1. A complete susceptibility assessment, or documentation of prior submittal to DOH **(Deadline: July 1995)** — **Y** ❑

DELINEATION

2. If CFR is used, the pumping rate (quantity) and screened interval of the well. **(Deadline: July 1995)** — **Y** ❑

3. Map of the 1, 5, and 10-year time of travel zones plotted on an appropriate scale map (see text). — **Y** ❑

4. An explanation of the methodology if site-specific delineation is used. **(Deadline: July 1996)** — **Y** ❑

5. A list of those notified of the wellhead protection area (WHPA) boundaries, along with an example notification letter. **(Deadline: July 1996 if CFR is used; July 1997 if more site-specific method is used)** — **Y** ❑

INVENTORY

6. A list of the potential contaminant sources in the WHPA, grouped by time of travel zones, as derived from the inventory. **(Deadline: July 1996 if CFR is used; July 1997 if more site-specific method is used)** — **Y** ❑

7. List of owners/operators of potential and actual contaminant sources notified of their location in the WHPA (along with example notification letter). **(Deadline: July 1996 if CFR is used; July 1997 if more site-specific method is used)** — **Y** ❑

8. List of regulatory agencies and local governments notified of the location of potential and actual sources of ground water contamination within the WHPA. **(Deadline: July 1996 if CFR is used; July 1997 if more site-specific method is used)** — **Y** ❑

CONTINGENCY AND EMERGENCY RESPONSE PLANS

9. A contingency plan for an alternative source of potable water (see text for details). **(Deadline; July 1996 if CFR is used; July 1997 if more site-specific method is used)** — **Y** ❑

10. Documentation of notification to appropriate response agencies. **(Deadline; July 1996 if CFR is used; July 1997 if more site-specific method is used)** — **Y** ❑

Appendix B-2
Generic Scope of Work

This is a generalized scope of work that may be useful to purveyors developing a workplan prior to initiating your local wellhead protection program.

If elements are contracted out to consultants, it may be appropriate to include a statement that the contracted element(s) must be completed so as to meet the requirement of WAC 246-290.

GOAL 1

Characterize the hydrogeologic setting the well, wellfield, or spring is withdrawing water from. This includes the determination of values of hydraulic conductivity, ground water flow gradient, effective porosity, and pumping rate to use for delineating wellhead protection areas as presented by EPA and DOH guidance documents.

Task 1a: Map hydrogeologic systems contributing water to your source water. Utilizing existing geologic information and reports, define recharge areas. Present information in report form and also using (multiple) overlays on a map at a scale appropriate to show meaningful details.

Task 1b: Map water levels to determine regional gradient and direction of flow in the aquifers. Plot location of existing wells on base map. Select a set of test wells that will allow creation of a water level map. Access water level information from test wells obtained from/through local government agencies (*water level data collected locally using staff or local well drillers may save considerable money*). Create water level (potentiometric surface) map of the water bearing zone(s) of interest, at a scale appropriate to show meaningful details.

Task 1c: Aquifer property definition. Estimate (based on pump tests, field tests, or other defined methods) aquifer transmissivity, porosity, flow direction and rate (using all available data). Identify additional data needs and uncertainties in estimates, evaluate trade-offs in data used.

Task 1d: Delineation. Delineate capture zone of your source water. Identify recharge areas for the same. Use approved method (analytical model, hydrogeologic mapping, etc.) to delineate 1 year, 5 year and 10-year time of travel (or equivalent boundaries) for your source(s) of supply. Include model calibration as appropriate.

GOAL 2

Identify known and potential sources of ground water contamination within the Wellhead Protection Areas that pose threats to your source water.

Task 2a: Compile and evaluate locally generated inventory data. (By using staff or volunteers to collect the initial inventory data, a considerable amount of money may be saved.)

Task 2b: Identify and fill informational gaps in local inventory.

Task 2c: Plot inventory findings at a scale appropriate to show meaningful details.

Task 2d: Evaluate/ prioritize risks associated with the public water system. If appropriate, determine/estimate carrying capacity or assimilation capacity of systems for septic nitrate loading or other identified contaminants.

GOAL 3

Recommend management procedures to protect water supplies from potential sources of ground water contamination within the Wellhead Protection Areas.

Task 3a: Prioritize the relative risks of the potential sources of ground water contamination within each wellhead protection area.

Task 3b: Identify jurisdictional responsibilities for the identified risks in conjunction with the local Wellhead Protection Advisory Board.

Task 3c: In coordination with local governments, identify existing and proposed management programs (Washington Growth Management Act, Critical Aquifer Recharge Areas, local comprehensive plans, local ordinances, state programs, etc.).

Task 3d: Identify and recommend management alternatives available for pollution prevention and risk reduction measures. These recommendations are to include identification of funding source alternatives for the wellhead program.

Task 3e: Provide specific examples of suggested options, including example ordinances. Ensure that suggested options and sample ordinances are consistent with enabling legislations. Document that the purpose of the regulation is to advance legitimate government function (public health and safety).

Task 3f: Propose follow-up procedures to ensure preventative measures are effective.

GOAL 4

Develop contingency plans for the provision of alternative drinking water supplies in the event of contamination of existing water supplies.

Task 4a: Identify maximum capacities of the existing system(s) in relation to source, distribution system, and water rights restrictions. Assume loss of largest well/wellfield and reevaluate.

Task 4b: Evaluate the expansion options of the existing system(s)' capacities to meet current water rights/availability.

Task 4c: Identify existing or potential interties with other public water systems.

Task 4d: Evaluate current procedures and make recommendations on contingency plans for emergency events.

GOAL 5

Identify future potential sources of drinking water and recommend quality assurances and control methods to be applied to ensure protection of water quality prior to utilization as a drinking water supply.

GOAL 6

Define **critical** aquifer recharge areas for the well (wellfield, spring).

Task 6a: Provide site-specific recommendations on which portions of the recharge areas should be considered "critical" and therefore in need of special protection.

GOAL 7

Develop a spill / incident response plan.

Task 7a: Meet, brief and coordinate with local emergency responders on the wellhead protection program's findings (e.g. susceptibility assessment, wellhead protection area boundaries, inventory results, contingency plan conclusions). Discuss current response capabilities and resources from a ground water protection prospective.

Task 7b: Make recommendations on spill / incident response planning, training and resource needs.

GOAL 8

Complete draft and final reports discussing research conducted, field investigations, actions and recommendations.

Task 8a: Provide six (6) rough draft copies for review.

Task 8b: Participate in a minimum of two (2) public meetings and four (4) Wellhead Protection Advisory Committee meetings.

Task 8c: Develop a final written report incorporating review comments summarizing consultant activities and data provided by the Wellhead Protection Advisory Committee. Products are to include:

1. One (1) camera ready copy of the final report,
2. Fifteen (15) copies of the final report,
3. A copy of the report text on computer disk, and
4. Six (6) Mylar copies of each base map and overlay.

Appendix B-3
Sample Notification Letters

Example Letter 1 **To local jurisdictions / agencies**

Dear (Agency/Local Government):

As part of the wellhead protection program for the Taylor Gulch Water Company, we are hereby informing you of the findings of our wellhead protection area delineation. This is in accordance with State regulations (WAC 246-290-135).

Our company has 450 service connections, and serves a population of approximately 1,071 people. The State Department of Health has given our system a rating of "highly susceptible". This means that our drinking water supply is very vulnerable to contamination.

The enclosed map shows the 1, 5, and 10-year time of travel boundaries for our wellhead protection area. Any ground water contamination that occurs within this wellhead protection area has a high potential to reach our well. It is therefore of utmost importance to us that all reasonable steps be taken to ensure that land use activities within this area do not contaminate our customers' drinking water supplies.

Thank you for your support in protecting our drinking water.

Sincerely,

Example Letter 2 **To Potential Source Owners/Operators**

Dear (Owner/Operator):

In order to protect the drinking water supply for the customers of Taylor's Gulch Water System, we are developing a wellhead protection program in accordance with State requirements. As part of our wellhead protection program, we mapped the area overlying the short-term recharge zone of our drinking water supply wells. This is called our wellhead protection area.

Following the mapping of the wellhead protection area, we conducted an inventory of **potential** sources of ground water contamination within the area. The nature of your business and its location within our wellhead protection area means that your activities have the potential to affect our customers' drinking water supply.

We have notified the regulatory agency(ies) that regulates your type of business/facility of your presence within our wellhead protection area. You should contact them to request technical assistance to help manage your business in a way that will best prevent ground water contamination. We realize you are already careful to protect the environment as you conduct your business. We hope that informing you of your location in our wellhead protection area will result in an increase in precautions to ensure that your activities will not impact our drinking water quality.

Sincerely,

Appendix C
Contact Names, Addresses, and Phone Numbers

Washington State Department of Health Wellhead Protection Program contacts:

Headquarters
David Jennings
PO Box 47849
Olympia, WA 98504-7849
360-236-3149

Eastern Regional Office
Megan Harding
1500 West 4th Avenue, Suite 305
Spokane, WA 99204
509-456-2717

Deana Pavwoski
1500 West 4th Avenue, Suite 305
Spokane, WA 99204
509-456-5067

Northwest Regional Office
Richard Rodriguez
20435 72nd Avenue South, Suite 200
Kent, WA 98032
253-395-6771

Linda Scott
20435 72nd Avenue South, Suite 200
Kent, WA 98032
253-395-6770

Southwest Regional Office
Karen Klocke
PO Box 47823
Olympia, WA 98504-7823
360-664-2999

Washington State Department of Ecology contacts:

Hazardous Waste and Toxics Reduction Program
PO Box 47600
Olympia, WA 98504-7600
360-407-6700

Hazardous Waste Clean-up Sites
800-826-7716

Water Resources Program/Well Identification
Dick Szymarek
PO Box 47600
Olympia, WA 98504-7600
(360) 407-6648

Water Quality Program
PO Box 47600
Olympia, WA 98504-7600
(360) 407-6600

Central Regional Office
15 West Yakima Avenue, Suite 200
Yakima, WA 98902
(509) 575-2490

Eastern Regional Office
Mark Ader
4601 North Monroe
Spokane, WA 99205-1295
(509) 329-3400

Northwest Regional Office
Melissa Snoeberger
3190 160th Avenue SE
Bellevue, WA 98008-5452
(425) 649-7000

Southwest Regional Office
Igor Vern
300 Desmond Drive
Lacey, WA 98503
(360) 407-6300

Other State Agency contacts:

Municipal Research and Services Center
John Carpita
2601 4th Avenue, Suite 800
Seattle, WA 98121-1280
(206) 625-1300

Washington State Department of Agriculture
Pesticide Management Division
Ann Wick
PO Box 42589
Olympia, WA 98504-2589
(360) 902-2051

Washington State Department of Community Trade & Economic Development
Growth Management Division
Chris Parsons
PO Box 48300
Olympia, WA 98504-8300
(360) 725-3058

Washington State Department of Community Trade & Economic Development
Public Works Trust Fund
PO Box 48319
Olympia, WA 98504-8319
(360) 586-4120

Washington State University/Cooperative Extension contacts:

Water Quality Management Team
Robert Simmons
WSU Cooperative Extension
11840 Highway 101 N
Shelton, WA 98584-9709
(360) 427-9670 ext. 395

Western Washington Water Quality Coordinator
Pat Pearson
201 West Patison
Port Hadlock, WA 98339
(360) 379-5610

Agriculture & Natural Resource Program
Edward Adams
WSU Cooperative Extension
PO Box 1459
Spokane, WA 99210-1459
(509) 358-7960

Federal Agency contacts:

United States Department of Agriculture
Rural Development, Community Programs
Sandra Boughton
301 Yakima Street, Room 315
Wenatchee, WA 98801
(509) 664-0236

United States Department of Health & Human Services / Indian Health Service
Portland Area Office
(covers Oregon, Washington, and Idaho)
1220 SW Third Avenue, Room 476
Portland, OR 97204
(503) 326-2020

United States Department of Agriculture
Natural Resources Conservation Service
316 West Boone Avenue, Suite 450
Spokane, WA 99201-2348
(509) 323-2900

United States Environmental Protection Agency (EPA)
Office of Water
Jennifer Parker
1200 Sixth Street
Mail Stop: OW137
Seattle, WA 98101
(206) 553-1900

United States Geological Survey
Water Resources of Washington State
Water Science Center Office
1201 Pacific Avenue, Suite 600
Tacoma, WA 98402
(253) 428-3600

Appendix D
Washington State's Interagency Ground Water Committee

Participating agencies, entities, and organizations

Federal Agencies
United States Environmental Protection Agency
United States Geological Survey

State Agencies
Office of Superintendent of Public Instruction
Washington State Conservation Commission
Washington State Department of Agriculture
Washington State Department of Community Trade and Economic Development
Washington State Department of Ecology
Washington State Department of Fish and Wildlife
Washington State Department of General Administration
Washington State Department of Health
Washington State Department of Information Services
Washington State Department of Natural Resources
Washington State Department of Parks and Recreation
Washington State Department of Social and Health Services
Washington State Department of Transportation
Washington Utilities and Trade Commission

Counties
Clallam
Spokane
Thurston

Tribes
Chehalis
Squaxin
Suquamish
Tulalip

Other Organizations
University of Washington
Washington Association of Cities
Washington Association of Counties
Washington Association of Public Health Officers
Washington Public Utility Districts Association
Washington State University/Cooperative Extension
Washington Toxics Coalition

Appendix E
Susceptibility Assessment Form (Version 2.2)

This appendix includes:

- A Susceptibility Assessment Form (Version 2.2)
- An overview describing how water source vulnerability assessments will be used to implement the SDWA amendments
- An Assistance Packet with:
    - An introduction explaining how and why to complete the Susceptibility Assessment Form
    - Instructions to assist you in completing all sections of the Susceptibility Assessment Form
    - Appendix A: a complete Glossary of terms used
    - Appendix B: assistance for using a topographic map and an Example Map
    - Appendix C: a labeled diagram of a model drinking water supply well
    - Appendix D: assistance for using a well report and a sample well report
    - Appendix E: tables for determining the area of ground water travel time zones

NOTE: Please do not use the form included in this appendix to develop your susceptibility assessment. If you need to complete a susceptibility assessment for your system, contact your DOH regional office to obtain the most current version of the susceptibility assessment form. This copy of the susceptibility assessment form is included for illustrative purposes, but is subject to revision. **It is important to use the most current version of the assessment form.**

Ground Water Contamination
Susceptibility Assessment Survey Form
Version 2.2

IMPORTANT! Please complete one form for each ground water source (well, wellfield, spring) used in your water system.
Photocopy as necessary.

PART I: System Information

Well owner/manager:_____

Water system name:_____

County:_____

Water system number:_____ Source number:_____

Well depth:_____ feet (From WFI form)

Source name:_____

WA well identification tag number:_____ _____ _____ - _____ _____ _____

❑ Well not tagged

Number of connections:_____ Population served:_____

Township:_____ Range:_____

Section:_____ ¼ ¼ Section:_____

Latitude/longitude (if available):_____/_____

How was latitude/longitude determined?

_____Global positioning device_____survey_____topographical map
_____other:_____

*Please refer to Assistance Packet for details and explanations of all questions in Parts II through V.

PART II: Well Construction and Source Information

1) Date well originally constructed: ___/___/___month/day/year

last reconstruction: ___/___/___month/day/year

❑ Information unavailable

2) Well driller:_____

_____

_____

❑ Well driller unknown

3) Type of well:

___ Drilled: ❑ rotary ❑ bored ❑ cable (percussion) ❑ Dug

___ other: ❑ spring(s) ❑ lateral collector (Ranney)

❑ driven ❑ jetted ❑ other:_____

4) Well report available ❑ Yes (attach copy to form) ❑ No

5) Average pumping rate: _____(gallons/min)

Source of information_____

If not documented, how was pumping rate determined?_____

_____

❑ Pumping rate unknown

6) Is this source treated?

If so, what type of treatment:

❑ disinfection ❑ filtration ❑ carbon filter ❑ air stripper ❑ other

Purpose of treatment (describe materials to be removed or controlled by treatment):

_____

_____

7) If source is chlorinated, is a chlorine residual maintained: ❑ Yes ❑ No

Residual level:_____ (At the point closest to the source.)

PART III: Hydrogeologic Information

1) Depth to top of open interval: [check one]

❑ <20 ft ❑ 20-50ft ❑ 50-100ft ❑ 100-200ft ❑ >200ft

❑ information unavailable

2) Depth to ground water (static water level):

❑ <20ft ❑ 20-50ft ❑ 50-100ft ❑ >100ft

❑ flowing well/spring (artesian)

How was water level determined?

❑ well log ❑ other _____

❑ depth to ground water unknown

3) If source is a flowing well or spring, what is the confining pressure:

_____ psi (pounds per square inch) **or**

_____feet above wellhead

4) If source is a flowing well or spring, is there a surface impoundment, reservoir, or catchment associated with this source: ❑ Yes ❑ No

5) Wellhead elevation (height above mean sea level): _____ feet

How was elevation determined? ❑ topographic map ❑ Drilling/Well Log ❑ altimeter

❑ other:_____

❑ information unavailable

6) Confining layers: (This can be completed only for those sources with a drilling log, well log or geologic report describing subsurface conditions. Please refer to assistance package for example.)

_____ evidence of a confining layer in well log

_____ no evidence of a confining layer in well log

If there is evidence of a confining layer, is the depth to ground water more than 20 feet above the **bottom** of the **lowest confining layer**? ❑ Yes ❑ No

❑ information unavailable

7) Sanitary setback:

❑ < 100ft* ❑ 100-120ft ❑ 120-200 ft ❑ >200ft

* If less than 100ft, describe the site conditions:

_____

_____

_____

_____

8) Wellhead construction:

❑ wellhead enclosed in a wellhouse

❑ controlled access (describe): _____

_____

❑ other uses for wellhouse (describe): _____

_____

❑ no wellhead control

9) Surface seal:

❑ 18 ft

❑ <18 ft (no Department of Ecology approval)

❑ <18 ft (Approved by Ecology, include documentation)

❑ depth of seal unknown

❑ no surface seal

10) Annual rainfall (inches per year):

❑ <10 in/yr ❑ 10-25 in/yr ❑ >25 in/yr

PART IV: Mapping Your Ground Water Resource

1) Annual volume of water pumped:_____ (gallons)

How was this determined?

❑ meter

❑ estimated: ❑ pumping rate (_____)

❑ pump capacity (_____)

❑ other:_____

2) "Calculated Fixed Radius" estimate of ground water movement:
(see Instruction Packet)

6-month ground water travel time: _____feet

1-year ground water travel time: _____feet

5-year ground water travel time: _____feet

10-year ground water travel time: _____feet

Information available on length of screened/open interval?

❑ Yes ❑ No

Length of screened/open interval: _____feet

3) Is there a river, lake, pond, stream, or other obvious surface water body within the 6-month time of travel boundary?

❑ Yes ❑No (mark and identify on map)

4) Is there a stormwater and/or wastewater facility, treatment lagoon, or holding pond located within the 6-month time of travel boundary?

❑ Yes ❑No (mark and identify on map)

Comments:_____

_____

_____

_____

_____

PART V: Assessment of Water Quality

1) Regional sources of risk to ground water:

Please indicate if any of the following are present within a circular area around your water source having a radius up to and including the five-year ground water travel time:

- likely pesticide application _____ _____ _____ _____
- stormwater injection wells _____ _____ _____ _____
- other injection wells _____ _____ _____ _____
- abandoned ground water well _____ _____ _____ _____
- landfills, dumps, disposal areas _____ _____ _____ _____
- known hazardous materials clean-up site _____ _____ _____ _____
- water system(s) with known quality problems _____ _____ _____ _____
- population density >1 house/acre _____ _____ _____ _____
- residences commonly have septic tanks _____ _____ _____ _____
- Wastewater treatment lagoons _____ _____ _____ _____
- sites used for land application of waste _____ _____ _____ _____

Mark and identify on map any of the risks listed above which are located within the 6-month time of travel boundary. (Please include a map of the wellhead and time of travel areas with this form. Please locate and mark any of the following.)

If other recorded or potential sources of ground water contamination exist within the ten-year time of travel circular zone around your water supply, please describe:

_____

_____

_____

_____

_____

_____

2) Source-specific water quality records:

Please indicate the occurrence of any test results since 1986 that meet the following conditions:
(Unless listed on assessment, MCLs are listed in assistance package.)

A. **Nitrate:** (Nitrate MCL = 10 mg/l) YES

Results greater than MCL _____

<2 mg/liter nitrate _____

2-5 mg/liter nitrate _____

<5 mg/liter nitrate _____

Nitrate sampling records unavailable _____

B. **VOCs:** (VOC detection level 0.5 ug/l or 0.0005 mg/l) YES

Results greater than MCL or SAL _____

VOCs detected at least once _____

VOCs never detected _____

VOC sampling records unavailable _____

C. **EDB/DBCP:** YES

(EDB MCL = 0.05 ug/l or 0.00005 mg/l. DBCP MCL = 0.2 ug/l or 0.0002 mg/l.)

EDB/DBCP detected below MCL at least once _____

EDB/DBCP detected above MCL at least once _____

EDB/DBCP never detected _____

EDB/DBCP tests required but not yet completed _____

EDB/DBCP tests not required _____

D. **Other SOCs (Pesticides):** YES

Other SOCs detected

(pesticides and other synthetic organic chemicals) _____

Other SOC tests performed but none detected

(list test methods in comments) _____

Other SOC tests not performed _____

If any SOCs in addition to EDB/DBCP were detected, please identify and date. If other SOC tests were performed, but no SOCs detected, list test methods here:_____

_____

_____

_____

E. **Bacterial contamination:** YES

Any bacterial detection(s) in the past 3 years in samples taken from the source (not distribution sampling records)? _____

Has source (in past 3 years) had a bacteriological contamination problem found in distribution samples that was attributed to the source? _____

Source sampling records for bacteria unavailable _____

PART VI: Geographic or Hydrologic Factors Contributing to a Non-Circular Zone of Contribution

The following questions will help identify those ground water systems which may not be accurately represented by the calculated fixed radius (CFR) method described in Part IV. For these sources, the CFR areas should be used as a preliminary delineation of the critical time of travel zones for that source. As a system develops its Wellhead Protection Plan for these sources, a more detailed delineation method should be considered.

1) Is there evidence of obvious hydrologic boundaries within the 10-year time of travel zone of the CFR? (Does the largest circle extend over a stream, river, lake, up a steep hillside, and/or over a mountain or ridge?)

❑ Yes ❑ No

Describe with references to map produced in Part IV:

_____

_____

_____

2) Aquifer Material:

   A) Does the drilling log, well log or other geologic/engineering reports identify that the well is located in an area where the underground conditions are identified as fractured rock and/or basalt terrain?
   ❑ Yes ❑ No

   B) Does the drilling log, well log or other geologic/engineering reports indicate that the well is located in an area where the underground conditions are primarily identified as coarse sand and gravel?
   ❑ Yes ❑ No

3) Is the source located in an aquifer with a high horizontal flow rate? (These can include sources located on flood plains of large rivers, artesian wells with high water pressure, and/or shallow flowing wells and springs.)
   ❑ Yes ❑ No

4) Are there other high capacity wells (agricultural, municipal and/or industrial) located within the CFRs?

a) Presence of ground water extraction wells removing more than approximately 500 gal/min within…

	YES	NO	unknown
<6-month travel time	_____	_____	_____
6 month—1 year travel time	_____	_____	_____
1—5 year travel time	_____	_____	_____
5—10 year travel time	_____	_____	_____

b) Presence of ground water recharge wells (dry wells) or heavy irrigation within…

	YES	NO	unknown
<1-year travel time	_____	_____	_____
1—5 year travel time	_____	_____	_____
5—10 year travel time	_____	_____	_____

Please identify or describe additional hydrologic or geographic conditions that you believe may affect the shape of the zone of contribution for this source. Where possible, reference them to locations on the map produced in Part IV.

_____

_____

_____

_____

_____

_____

_____

Suggestions and Comments

Did you attend one of the susceptibility workshops? ❑ Yes ❑ No

Did you find it useful? ❑ Yes ❑ No

Did you seek outside assistance to complete the assessment? ❑ Yes ❑ No

This form and instruction packet is still in the process of development. Your comments, suggestions and questions will help us upgrade and improve this assessment form. If you found particular sections confusing or problematic, please let us know. How could this susceptibility assessment be improved or made clearer? Did the instruction package help you find the information needed to complete the assessment? How much time did it take you to complete the form? Were you able to complete the assessment without additional/outside expertise? Do you feel the assessment was valuable as a learning experience? Any other comments or constructive criticisms you have would be appreciated.

Susceptibility Assessments and Monitoring Waivers For Public Water Supplies

EPA and Vulnerability:

In 1986, Congress passed amendments to the Safe Drinking Water Act (SDWA). These amendments have been implemented in phases. The most recent phases to be implemented are Phase II and Phase V, which go into effect between 1993 and 1995. Phase II and V deal mainly with volatile organic and synthetic organic compounds (VOCs and SOCs). Under Phase II & V, the monitoring requirements for these compounds are significantly increased for public water systems. Realizing that the increased monitoring requirements can be very costly to water systems, EPA has allowed states to reduce or waive monitoring requirements depending upon how vulnerable the water system's sources are to contamination. That is, those sources which are vulnerable to contamination will have more monitoring requirements while those sources that are not vulnerable will have reduced or no monitoring required for many chemicals. The Washington State Department of Health (DOH) is actively pursuing monitoring waivers in order to eliminate unnecessary testing while still being fully protective of human health.

What is Vulnerability?

Vulnerability can be thought of as a water sources potential for contamination. Vulnerability is composed of two factors: the physical susceptibility to the infiltration of contaminants, and the source's risk of exposure to contaminants. Susceptibility is determined by conditions that affect the movement of contaminants from the land surface into a water supply. This would include the depth of the well, its construction, the geology of the area, the pumping rate, the source(s) of ground water recharge, and the aquifer material. The risk of exposure to contaminants is determined by whether or not contaminants were used in the area of a water supply. However, each type of contaminant may behave differently in the environment, making it difficult to accurately predict ground water pollution from surface exposure. For this reason, susceptibility is the key factor used in determining vulnerability.

When physical susceptibility data is incomplete, or where use of contaminants is highly unlikely, then vulnerability will be based more on risk of exposure.

Susceptibility Assessments:

In order to determine a drinking water sources vulnerability to surface contamination, DOH has developed the Susceptibility Assessment Survey Form. This survey form catalogs key susceptibility factors for each source in order to determine an overall susceptibility rating. The following information is needed to evaluate hydrologic susceptibility:

1) Well logs, or other indicators of aquifer characteristics,
2) Depth of open interval,
3) Date and description
4) Record of monitoring information (nitrates, VOCs, SOCs, and bacteria),
5) A specific (and accurate) location of the source,
6) Water level information,
7) Estimate of wellhead elevation
8) A general evaluation of land-use surrounding the wellhead, and
9) Size of the water system.

Monitoring Waivers:

Depending on the results of the susceptibility assessment, DOH may waive some or all of the monitoring requirements for many chemicals. This type of waiver is considered to be a "susceptibility waiver". If source information does not allow a system to qualify for a susceptibility waiver, the system can pursue other types of waivers. One option, the Contaminant Use Waiver, involves a more intense inventory of the contaminants that may be found within the source's recharge area. "State-wide waivers" may also offer some monitoring relief. These are blanket waivers granted for chemicals not commonly detected in the state (such as dioxin).

Another type of waiver currently being developed is the "Area Waiver". The 1994 legislature passed a bill directing DOH to develop the Area Waiver program. For this waiver, DOH conducted a ground water testing program throughout the state which has provided information on occurrence of SOCs. Susceptible systems within areas where SOCs have been detected will be required to do monitoring, whereas sampling will be reduced or waived in areas where there is little evidence that contamination may be expected. Information from this ground water study will also be considered, when evaluating surface water sources in these same areas. Participation in the Area Waiver system program, with its associated fee, is voluntary. If a system chooses not to participate, the system must complete the required sampling or use one of the other waiver options. For some susceptible surface water systems, the Area Waivers will provide a less expensive and less time-consuming alternative to either the required sampling or individual Contaminant Use waivers.

The fees associated with the Area Waiver program will follow the direction set by the legislations. Under the legislation, DOH received a loan to fund this program. The economics of the Area Waiver approach may allow some systems to benefit from a waiver without having to conduct extensive contaminant inventories or monitoring. As information on the area waiver program and waiver fees are finalized, we will send updates to the affected water systems.

All of the waiver options will have a fee attached to them. Carrying out the waiver program has had and will continue to have a significant impact on DOH resources. Each waiver request requires DOH review and evaluation. The costs for the various types of waivers are based on the time it takes the department to review the waiver request. Contaminant Use and Area Waivers will generally cost more than a susceptibility waiver, but they are still expected to offer systems a savings over the cost of full monitoring. If a system chooses not to apply for a waiver, there is of course no fee.

PLEASE NOTE: The building block of DOH's waiver program for ground water sources is the susceptibility assessment you have just received. **Regardless of the type of waiver you want to pursue, to be eligible for a waiver, you must first complete this form.**

Assistance Packet
Susceptibility Assessment Form

Introduction:

This questionnaire has been sent to you in order to help assess the susceptibility of your ground water source(s) to potential surface sources of contamination. The Washington Department of Health (DOH) will use the information on this form to evaluate geologic and hydrologic factors associated with each of your public water supply sources in order to estimate vulnerability to contaminants that are regulated under the State Drinking Water Regulations (WAC 246-290) and the Federal Safe Drinking Water Act (SDWA).

The information from this questionnaire, DOH records on water quality and water source development, and new SDWA testing results will all be considered in assigning frequency-of-monitoring requirements to each source for the contaminants regulated under the SDWA. Some of the information requested here will also be used to begin developing comprehensive plans for the protection of ground water resources throughout the state under the Wellhead Protection Program.

The information requested for this questionnaire may be gathered from a variety of records. Some information can be found on your Water Facilities Inventory (WFI) and reflects the current information in our computer system. Please take the time to verify this information. If this information is not current, please note any changes. Other useful records include your source and system monitoring records as well as Water Well Reports (well logs), system design plans, water right records, engineering reports, and water quality monitoring records. If your records are not complete copies, some of this information can be obtained form the Washington State Department of Ecology (Ecology) records or from your regional DOH office.

Many of the questions request information about the construction of your well. If your water system utilizes only springs, you should still complete the form—simply leave blank those questions which do not apply.

Incorrect information or incomplete questionnaires may raise your susceptibility risk rating and increase your future monitoring costs. For these reasons, it is important that you take some time to complete the form to the best of your ability. You may not have all of the information that is requested on the questionnaire. You may indicate "information unavailable/unknown" in response to certain queries if this is the case.

PART I: System Information

With a few exceptions, all of the information in this section can be taken from your WFI form. Your local health department should have a copy on file if your copy has been misplaced. Of particular concern is the information concerning source location and quarter/quarter section, well depth, population served and number of connections. This information is also available on your well log. Please use this opportunity to review your WFI and make sure it is up-to-date.

There are optional items in this section. These include the Washington Well Identification Number and a latitude and longitude location. At the present time, this information is not readily available to some of our water systems. If this is the case, these areas can be left blank. In the future, DOH expects that this information will be available to more system managers. At that time, the susceptibility questionnaire will be updated.

PART II: Well Construction Information

Most of the well information can be obtained from the Water Well Report(s) (well log) and design plans that were prepared for the water system. In some cases, the information may be found in other system records. Estimates can be made for some factors, but these responses must be identified as estimates. An annotated example of a drilling log can be found in Appendix D of this packet.

1) Date Well Constructed/Reconstructed:

This information can be found on the well log by the driller's signature. If you have multiple logs representing reconstruction or redevelopment of the well, use the most recent date. Please include a copy of the well log with this form.

2) Well Driller:

This can be found on the lower right side of the well log. Please enter the name and address if possible.

3) Well Type:

Mark the type of well construction. It can often be found in part 4 on the left side of the well log. If this area has not been filled in, please check system records. Appendix A of this packet contains a list of definitions to assist you in the determination of well type if you have no documentation.

4) Well Report (Well Log):

This would include a driller's log, well log, or a detailed design that includes an engineer's "as built" along with a geologic log. Your Ecology regional office may have a copy of a well log(s) for your system if you cannot locate one in your files. Please attach a copy to your response form.

5) Average Pumping Rate:

This may be available on your WFI (box 24), well log (box 9), or from the system plan. It is an estimate of the pumping rate in gallons per minute. If the current pumping rate is different than

that listed on the well log or WFI, or if these documents are absent, please explain how the pumping rate was determined.

6) Source Treatment:

If your water source is treated in any way prior to delivery to your customers, you must record that information here. Many water sources are not treated. Of those that are, chlorination (for disinfection) is the most common. Some other common types of water treatment include: other types of disinfection, filtration, fluoridation, or softening (to remove unwanted minerals or chemicals).

It is possible that your system has more than one source that is combined prior to treatment. If that is the case, please record this information in the comment section. Please refer to your Water Facilities Inventory (WFI) for treatment information if you are uncertain.

7) Chlorine Residuals:

To be completed only for those sources that are chlorinated. If your system is chlorinated, please record the average chlorine residual for that source (within the distribution system). If more than one source is combined before treatment, be sure to record the same information on both susceptibility assessments.

PART III: Information of Hydrogeologic Setting

1) Depth to Top of Open Interval:

This is the depth to the top of the screen/perforated area of the well. If there is more than one screened interval, use the depth to the top of the uppermost one. If the well is not fully cased, use the depth to the bottom of the casing. This information is generally found on the well log (part 6) or in an engineer's "as built" design report. If the well is cased but there is no screen(s), simply mark the depth to the bottom of the casing.

2) Depth to Ground Water:

On the well log, this would be listed in part 8. It is the depth to water in the well measured from the top of the well. It is the standing level of water in the well. It may be significantly different from either the depth of the well or the top of the open interval. If this information is not available on the well log, a current water level measurement can be used as an estimate. If the well is under pressure, or is a flowing well or spring, please mark the form accordingly.

3) Flowing Wells and Springs:

If this source is a flowing well (artisan, or free flowing well) or is a spring that flows, is there a measure of the flowing or confining pressure? This is an alternative way to measure the aquifer pressure associated with a source. Some artisan wells and springs are under pressure and flow freely at the land surface without the aid of a pump.

This information may be listed in pounds per square inch (psi) or as a flow rate in gallons per minute (gpm). If the information is listed as a flow rate, be sure it is not a pumping rate. The pumping rate will be used to answer questions in Part IV.

4) Surface Impoundment and Reservoirs:

If your source is a flowing well or spring, does it include a surface impoundment, reservoir, pond, catchment basin, or lake as part of its collection system? For this question, surface impoundments do not include closed or covered spring boxes, but refers to impoundments that are open to the atmosphere.

5) Wellhead Elevation:

This is the elevation above sea level of the top of the well casing (part above the ground). Sometimes this information can be found on the well log in part 8. An estimate can be made by altimeter or by using a topographic map and (with elevation contour lines) estimating the approximate elevation of the wellhead. Elevation can also be estimated relative to another known elevation. If an alternative method is used, please explain how the estimate was made.

6) Confining Layers:

This section can only be completed with the use of a well log or geologic log. The log will show the layers of material that were encountered during drilling (see the Sample Well Log, Appendix D of this packet, for an example). These layers may be described in the log as cobbles, gravel, sand, rock, fractured rock, basalt, silty sand, till, hardpan, or clay. The log should also identify the layers that yielded water. They may be clearly identified or simply noted as "wet" or "seepage". Generally, the most productive water-bearing zone is where the well has been screened.

Find the zone where the well is screened or open. Look at the materials encountered above that point. Do any of the layers consist of fine silty sands, clays, unfractured rock, hardpan, or till? If so, these may be considered to be impermeable (confining) layers which may serve to protect the aquifer from surface contamination.

If you can identify individual layers > 5 ft thick, or a combination of layers > 10 ft thick, mark this as evidence of a confining layer on the form. Once you have identified this layer(s), you can estimate the effectiveness of the protection afforded by the confining layer(s). To do this, subtract the depth to the static water level from the depth to the bottom of the lowest confining layer. If this number is positive and > 20 ft, there is a high likelihood that the aquifer as at least partially confined. The elevated water level is a simple measure of the pressure in the aquifer due to its confining geology. Generally, the greater the pressure the greater the protection.

Example:

Total amount of confining layers identified in driller's log:_____ft

If total is >10 ft for multiple layers or the total is >5 ft for a single confining layer, then…

Depth to bottom of lowest confining layer: _____ft

Subtract (-)
Depth to static Water level _____ft

Result (=) _____ft

If result is greater than (>) 20 ft, the source can be considered confined.

7) Sanitary Setback:

Public water systems are required to establish a control zone around the well that excludes major potential contaminant sources. Generally, it is approximately 100 ft but may be larger or smaller in some cases. This is the area protected by covenants and easements. This area should exclude buildings, roads, driveways, storage facilities, drainfields, and other possible contaminant sources. Please mark the distance established for the water source(s). This may be identified in records as a sanitary control zone. This data may also be collected by direct measurement.

8) Wellhead Construction:

Note if there is a well house constructed around the pump and wellhead built specifically to protect the wellhead. Is there controlled access to the wellhead (fenced area, locking cap or access port)? If the wellhead is housed in a building used for other purposes (storage of treatment materials, etc.), please describe.

9) Surface Seal:

The surface seal (sanitary seal) of a well commonly extends some distance down the annular space (the space between the well casing and the borehole wall) to protect the well from direct infiltration of surface contaminants. Since 1988, Ecology has required 18 feet of surface seal for most well construction. Please indicate if your well was constructed with at least 18 feet of cement, bentonite or grout seal below the surface.

10) Annual Rainfall:

Choose the appropriate estimate of annual rainfall. If you are unsure of your annual rainfall, try contacting your local Chamber of Commerce, a local airport, or the Weather Service. A map of average precipitation has been provided in Appendix F of this packet.

PART IV: Mapping Your Ground Water Resource

This section introduces a simple method for estimating the size of the area overlying the ground water resource which you will tap over the next 6 months, 1, 5, and 10 years. The method is called the "Calculated Fixed Radius" (CFR) method because the area it describes is a circle, which has an equal radius in all directions. The radius is the distance from the center to the outer edge of the area. Part IV of this questionnaire is intended to help you evaluate the appropriateness of using the CFR method for describing the shape of the ground water resource tapped by your particular water supply source(s). Data collected here will be applied in future efforts to delineate Wellhead Protection Areas to minimize risk to your water system from ground water pollutants.

1) Annual Volume of Water Pumped:

Use water meter data to respond to this question if your source is metered. If your source is not metered, you will have to estimate your annual water volume (gal/year). If you know your pumping rate (gal/min) you can estimate annual usage in the following manner:

_____ gal/min x 60 min/hr x _____ hr/day x _____ day/year = _____ gal/year

The next best method would be to substitute the value for pump capacity in place of pumping rate to estimate annual usage.

A third alternative would be to estimate your annual pumping based on the number of service connections on your system. For planning purposes, the Washington State Department of Health considers 400 gallons a day per connection to be an average rate of consumption. This method works best for small community systems with sings primary sources. With this method, the calculation would be:

# of service connections	x 400 Gallons per day per connection	x Average use days/year (365 for most)	= Estimated average pumping rate per year
50 connections	x 400 gallons / day / connection	x 365 days per year	= 7,300,000 gallons /year

2) "Calculated Fixed Radius" Estimate of Ground Water Movement:

This is a method of determining a circular area around your wellhead which is an estimate of the area overlying the ground water you will pump through your well over some period of time. The travel time of ground water from the edge of the circle to your well is dependent on the radius of the circle. The radius of a circle around your well representing 6 months, 1, 5, and 10-year travel times may be estimated by using the appropriate table in Appendix E of this packet. "Screened Interval" in the tables refers to the length of screened water inlet in the well through which water is pumped from the aquifer. If there is more than one screened interval, add the lengths together and use the sum for this value. In an unscreened well, the equivalent term is "Open Interval". This information may be available on your well log (part 6) or engineering reports. It is possible that your well has no screened (open) interval. If this is the case, or if you are unable to obtain this information, use the table for Screened Interval = 10 feet.

In using Appendix E of this packet, you must round your numbers to choose the appropriate values for your ground water travel times. There are four tables in Appendix E, you should use only one. Choose the table for a length of screened interval which is closest to the length of screened interval in your well. If your length is exactly between two values, choose the smaller length. Likewise, choose an annual volume of water pumped which is closest to your own value.

Appendix B of this packet provides a detailed example of how to calculate and plot the 1, 5, and 10-year time of travel CFRs around a source. As in the exercise, your areas recommend using a 7 ½ minute U.S. Geological Survey topographic map or larger. This is a map with a map scale of 24,000:1 or approximately 2.5 inches per mile. You may wish to use a map with a

larger scale (3-4 inches per mile) in order to make locating potential contaminant sources easier.

3) Surface Waters Within Wellhead Zones:

This question helps identify any obvious surface water bodies located within the 6-month travel time zone around the source. An obvious surface water body could be any seasonal or permanent water body such as lakes, ponds, wetlands, reservoirs, lakes, and streams. They can be human built or natural.

4) Stormwater or Wastewater Facilities Within Wellhead Zones:

This question identifies any potential biological contaminant source located within the 6-month travel time zone that may be associated with waste, wastewater, or stormwater disposal systems. This can include wastewater treatment lagoons, stormwater retention ponds, spray fields, and water or manure holding lagoons.

PART V: Assessment of Water Quality

The purpose of this section is to evaluate existing evidence of water quality problems in your specific water supply source(s) and to inventory possible threats to future water quality in order to minimize the risk of future contamination. You may have to make estimates of local conditions.

1) Regional Sources of Risk to Ground Water:

This question assesses the possibility of introduction contaminants into ground water from human sources (nitrates, coliform bacteria, pesticides, household/industrial solvents, hazardous wastes, etc.). Although contamination can occur at some distance from your water source(s), the emphasis here is on the area around the wellhead represented by a circle with a radius equivalent to a 5-year ground water time of travel.

"Likely pesticide application" refers to those areas, excluding residential areas, where insecticides or herbicides are commonly applied. Examples include agricultural land, managed forestland, nurseries, and recreational areas (golf courses, parks) all with areas greater than about 2 acres. Also consider right-of-ways (state/county highways, railroads, electric/telephone lines) where herbicides are applied and mosquito/vermin control areas. State and County Public Works Departments and County Agricultural Extension Offices can often supply much of this information.

"Other injection wells" can include French drains (stone-lined pits or trenches) into which liquid waste is poured and allowed to percolate into the ground.

Local governments and health departments may also be able to provide information concerning known contaminant sources such as landfills, clean-up sites, permitted waste discharge sites and businesses or industries that store or dispose of significant quantities of dangerous or hazardous waste materials in the immediate vicinity of your water supplies (service stations, auto shops, dry cleaners, chemical manufacturing/processing, etc.). This information may also be obtained by contacting the Ecology regional office nearest you. Telephone numbers of municipal, county, and state agencies can be found in the government listings in the White Pages of your telephone directory.

If you are unable to obtain sufficient information from public agencies to respond to this question, a simple alternative is to identify the area on a local map and complete either a walking or driving survey of the area, noting potential sources of contamination such as those described above.

In either case, a map should be completed with the locations of these risk sources relative to your water source indicated. Mark by legend (see Appendix B) on the map the location and type of activities that occur within the vicinity of your water supplies. A topographic map, as requested in Part IV of this questionnaire, is best used for this purpose or you may use the Map Sheet provided with this form. If you utilize the Map Sheet, please also sketch in the location of railways and major roads. Only one map is necessary for responding to both questions.

2) Source Specific Water Quality Records:

The following five sections will require the review of your water quality testing records. Of primary interest are any records indicating past (last 6 years) water quality problems for your source(s). If you do not have source specific records, use the system records for each individual source.

A) Nitrate Monitoring History

The State Maximum Contaminant Level (MCL) for nitrates is 10 mg/l. Levels between 5 and 10 mg/l may indicate some nitrate leaching from surface sources. Note in the appropriate boxes whether you have had nitrate detections below the MCL.

B) Volatile Organic Compounds (VOCs)

MCLs and State Advisory Levels (SAL)s vary for each VOC. Use DOH or lab notification of MCL violations. VOCs are "reported" (not an MCL violation) at concentrations of 0.5 ug/l (parts per billion), a level which often triggers additional sampling. These are listed on your lab forms as "detections". Appendix G of this packet includes a list of all of the organic chemical MCLs. Trihalomethane (TTHM) data should not be considered here.

C) EDB/DBCP

If you have been requested to sample for these 21 counties only, please use those results. If you do not live in a county required to test for these chemicals, please not that on your form. All Group A community water systems in the following counties have been requested to complete an initial round of EDB/DBCP testing prior to the end of 1993.

Counties with EDB/DBCP Testing Requirements:

Adams	Benton
Columbia	Franklin
Grant	Klickitat
Okanogan	Snohomish
Thurston	Whatcom
Yakima	Chelan
Asotin	Garfield
Douglas	Lincoln
Kittitas	Spokane
Skagit	Whitman
Walla Walla	

D) Synthetic Organic Compounds (SOCs)
If you have already completed any pesticide monitoring in addition to EDB and DBCP the results should be recorded in this section.

E) Bacterial Contamination
Use coliform monitoring records to respond. IMPORTANT: The main emphasis in this set of questions is to identify those water sources that have a history of source related bacterial contamination. Most of the current bacterial testing is done within a system's distribution system and not at the source. Bacterial contamination in the water system does not necessarily indicate contamination of the ground water source.

PART VI: Geographic or Hydrologic Factors Contributing to a Non-Circular Zone of Contribution

These four questions are intended to help a water system identify the sources where a Calculated Fixed Radius (CFR) may not accurately represent ground water conditions. The CFR delineation method is simple and relatively easy to apply, however, it is based on a number of assumptions concerning the aquifer and underground conditions. Very rarely are all of these assumptions true. These questions can help you and DOH evaluate the appropriateness of the CFR for Wellhead Protection planning or for long-term vulnerability assessments. However, for this initial evaluation, the CFR does provide a preliminary estimate of the critical time of travel zones. For those systems that answer yes to some or all of the following questions, the CFR time of travel zones may need to be improved or replaced with a more appropriate delineation model.

1) Hydrologic Boundaries:

Hydrologic boundaries are natural features in the earth which shape ground water flow patterns. Examples include surface streams, lakes, reservoirs, mountains, ridges and other steep changes in elevations. A topographic (topo) map is useful in determining whether such features are present within the circular area around your source(s) having a 10-year travel time radius. If possible, simply attach to this form a copy of such a map with your water source(s) marked and labeled.

Topo maps can be purchased locally throughout the state at map stores, camping stores, etc. You may need more than one map to include the 1, 5, and 10-year ground water travel zones around your source(s). If you use a U.S. Geologic Survey topographic map, please use one that is based on a 7 ½ minute scale. See Appendix B of this packet for notes on using a topo map for this purpose and for an example map. A blank map sheet is included in your response form if you are unable to obtain a topographic map of your area of concern.

Please indicate possible hydrologic boundaries and water source location(s) on the blank map sheet and affix to the response form. For the completion of this question however, as well as for responding to the first question in Part V, use of a topo map is recommended.

2) Aquifer Material:

These questions help identify those sources that may be found in geologic conditions that may affect the sources overall susceptibility. An important consideration can be the nature of the

material that makes up the underground environment and forms the aquifer. The information needed to answer these questions can be found in the drilling log, well log or geologic report.

A) Does the drilling log, well log, or other geologic/engineering report indicate that the well is completed in an area where underground conditions include fractured rock and/or basalt terrain? (These conditions are very common in central and eastern Washington, especially for deep wells). Besides basalt or lava, other fractured rock conditions may include sandstone, granite, limestone, and shale. These should be identified on the log.
B) Does the drilling log, well log, or other geologic/engineering report indicate that the well is completed in an area where underground conditions include multiple or extensive layers of coarse sand or gravel? These may be identified in the drilling logs as: gravelly sands, sands and gravel, cobbles, gravel, boulders, or pebbles. These materials are often associated with rivers, floodplain, and or glacial outwash deposits.

3) Evidence of High Horizontal Flow Rate:

This question will help identify those wells that are located in settings that produce very high natural ground water flow rates. In these settings, it is possible that the area of contribution around the well is influence more by the aquifer flow conditions than by the pumping rate of the well. Under these conditions, the time of travel zone around the well may be highly elongated and not circular. Some examples of these types of setting include: flood plains of large river systems, aquifers with very gravelly conditions (Spokane River Valley), artisan wells (deep flowing wells) with high water pressure, and shallow flowing wells or springs.

4) High-Volume Wells:

Indicate if you are aware of other high-capacity ground water wells (> 500 gal/min) removing ground water from within each fixed-radius distance from your source(s). Indicate if there exist large recharge wells (i.e. stormwater run-off/dry wells) or large-scale irrigation within these areas. Both of these types of activities can have a tremendous effect on the shape aquifer around them. If there are other physical conditions located around your well that you believe may affect the flow to your well, you can identify them in this section and reference them to the map that you produced in Part IV.

Appendix A: Glossary

Access Port: A tapped hole or tube at the wellhead, equipped with a cap, which provides access to the inner casing for measurement of the depth to water in the well.

Alluvial Deposits: Strata which were laid down by water, commonly consisting of gravels, sands, and silts, which usually have a high capacity for conducting ground water.

Annular Space: The space between the outer and inner casing of a well, or the space between the wall of the well and the casing if there is only one casing.

Aquifer: A geologic formation capable of yielding a significant amount of ground water to wells or springs. A ***confined aquifer*** is located beneath a formation with significantly lower permeability such that water cannot readily move in a vertical direction between the surface and the aquifer.

Bentonite: A mixture of clay-like minerals which swell in contact with water, often used in constructing surface seals.

Casing: A metal or plastic pipe installed in a well to maintain the well opening, especially in loose or unconsolidated formations.

Coliform bacteria: A type of bacteria which is associated with fecal contamination of water. They are used as an indicator of the sanitary quality of water.

Cone of Depression: The shape formed by the lowering of the water table in the area around a well. It is caused by the movement of water from the aquifer into the well during pumping.

Consolidated Deposit: A geologic formation which is "solid" rock such as granite, basalt, sandstone, shale, limestone, etc. These deposits may be permeable to water due to fractures in the rock.

Drawdown: The measured difference between the static water level in a well and the water level after some period of pumping.

Dry well: An artificial recharge well, such as a stormwater runoff pit, where collected water is allowed to percolate into the ground.

EDB/DBCP: Ethylene Dibromide and Dibromochloropropane. Two compounds, used as soil fumigants in some areas, which have cancer-causing properties and which may threaten ground water supplies.

Formation: A geologic unit which has relatively uniform characteristics, in this case especially regarding ground water movement.

Ground water: Water which occurs in subsurface opening in the earth, such as the spaces between particles in unconsolidated deposits or along fractures in consolidated deposits.

Gravel Pack: Gravel and/or sand placed in the annular space around the well screen to prevent fine materials from entering the well, increase well yield, and support the screen.

Grout: A mixture of cement, bentonite, and water used to seal the annular space between the inner and outer casings in a well, or between the casing and the wall of the well if there is only one casing.

Impermeable Deposits: Formations consisting of material through which water is unable to pass, such as clays and unfractured rock.

Nitrates: The compounds formed from nitrogen sources in surface soils and waters. In ground water, they indicate the infiltration of surface water into an aquifer. Nitrates also have toxic properties themselves, particularly to infants.

Permeable Deposits: Formations which permit the passage of water such as gravel and clean sand.

Recharge: Surface water which enters into a ground water system. This can be ***natural recharge***, such as from precipitation, or ***artificial recharge***, such as from irrigation or dry wells.

Sanitary Seal: see surface seal.

Saturated Zone: The vertical zone beneath the surface where all openings are filled with water.

Screen: A metal or plastic slotted tube used to maintain the well opening in unconsolidated aquifer formations and admit water being pumped from the aquifer.

Static Water Level: The vertical distance from the surface of the ground to the water level in a well when the water level is not affected by drawdown due to pumping.

Surface Seal: The grout seal which encloses the well casing at the surface and extends some distance beneath the surface to prevent surface water from infiltrating the well.

Synthetic Organic Compounds (SOCs): A general term for man-made compounds such as pesticides and various specialty chemicals. Many are regulated in drinking water because of their negative impacts on human health, particularly cancer promotion.

Trihalomethanes (THMs): A class of compounds which result from the interaction of chlorine in chlorinated drinking water with naturally occurring organic material in water. Some THMs are regulated because of the possibility that they may promote cancers.

Unsaturated Zone: The vertical zone beneath the surface where the openings are filled with both air and water.

Vadose Zone: see unsaturated zone.

Volatile Organic Compounds (VOCs): A type of synthetic organic compounds which have the ability to vaporize at room temperature, such as solvents, degreasers, fuels, and oils.

Water table: The water table is the water level in the saturated zone where the water pressure is equal to atmospheric pressure. In practical terms, it is equivalent to the static water level.

Wells: The following is a description of various well types:

Drilled Wells: Mechanically constructed wells characterized by the use of rotary, cable tool, or auger rigs for drilling. Often completed to depths greater than possible with other methods.

Rotary Wells: Drilled using circulating fluid (usually water or mud) in the borehole to support the borehole walls during drilling, eliminating the need for temporary casing. Drilling is accomplished with a rotating drill bit. Commonly used for construction of deep wells.

Bored Wells: Constructed with screw augers. Usually relatively shallow wells in soft, cohesive formations such as clays and silts.

Cable Tool (Percussion) Wells: Constructed by raising and dropping a heavy weight with a chisel bit. Borehole walls must be supported by temporary casing during construction. More common at shallower depths than rotary drilled wells.

Dug Wells: Hand-excavated wells, commonly wider and shallower than drilled wells. The sidewalls may be supported by materials such as masonry or concrete rings.

Other Wells:

Springs: Natural ground water seeps to the surface where the water table intersects the land surface. Water flow can vary annually and seasonally.

Later Collector Well (Ranney): A large-diameter well, sunk to the aquifer, with horizontal boreholes drilled out from the central well. Commoner in thin aquifers in alluvial deposits, especially adjacent to a river.

Driven Well: Built by driving a casing with a screened drive point into an aquifer. Used in permeable surface aquifers.

Jetted Well: Constructed by utilizing a high-pressure water jet to cut a hole in unconsolidated materials.

Appendix B

Using a Topographic Map for Siting Contaminant Sources

The fist task is to locate your source(s) on the map(s). Before purchasing any maps, you should calculate the distance of your 10-year ground water travel time in Part IV, question 2. You will need to have a map which covers the area of a circle around your well with a radius equal to this distance. It is quite possible you will need more than one map to complete this task.

Every topographic map will define the scale used on the map. For example, a common scale used on United States Geologic Survey (USGS) maps is 24,000:1, where one inch on the map equals 24,000 inches on the ground (or 2000 feet). If, for example, you wish to determine the map length of a distance of 923 feet on the ground, you would proceed in the following manner:

24,000 inches x (1 foot / 12 inches) = 2000 feet

(1 inch / 2000 feet) x (932 feet) = 0.0005 x 923 = 0.46 inches

So, a distance of 923 feet on the ground is approximately equal to one half inch ***on a map with a scale of 24,000:1.***

In this case, you would measure a distance of one half inch from your water source on your map and then draw a circle around your source with this distance for the radius. You should end up with three circles on your map around your water source(s) representing the 1, 5, and 10-year ground water travel times calculated in Part IV, question 2. If you have a wellfield, remember to treat the wells as a single source.

Sources of potential contamination identified in Part V, question 1, can be most easily indicated on the map(s) by designating each type of risk with a number and then including a legend with the map. You may wish to use a map with a larger scale (more inches to the mile) when you plot the areas around your well. A good scale to use is 3 to 4 inches per mile. You can use your existing topographic map and have it enlarged on a copier. Be sure to mark a mile length line on the map before you enlarge it. To determine the scale of the enlarged map in inches per mile, merely measure the line with a ruler.

The example map on the next page has been enlarged to a scale of 14,090:1 or 4.5 inches per mile.

Example Map

WATER SOURCE: Example Well 1 MAP SCALE: 14,080:1 or 4.5 inches/mile
Screened Interval: 10 feet
Annual Volume of Water Pumped: 50,000,000 gallons

From the tables for determining ground water times of travel, we determine that the 6-month, 1, 5, and 10-year travel times are, respectively, 700, 980, 2,200, and 3,110 feet. The map scale is 14,080:1, thus, we calculate that the radii of the travel time zones as follows:

6 month:	0.63 inches (approx. 5/8 inch)
1 year:	0.89 inches (approx. 7/8 inch)
5 year:	2 inches
10 year	2.8 inches (approx. 2 ¾ inches)

With the source at the center, three circles are drawn with these distances as the radius of each consecutive circle.

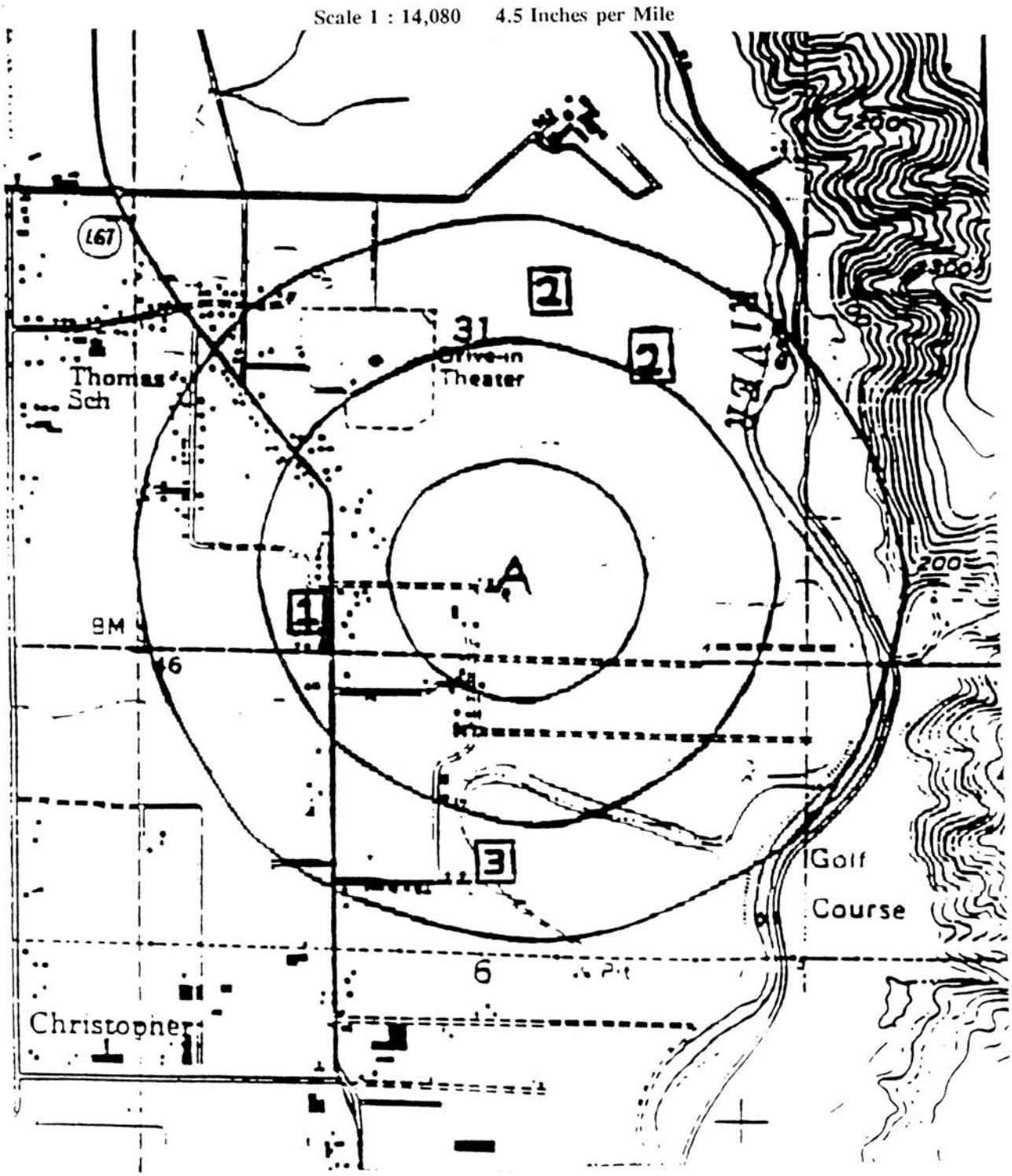
On the example map, possible contaminant sources are designated by number rather than attempting to write directly on the map. A key to the map might look like this:

Example Map – Legend

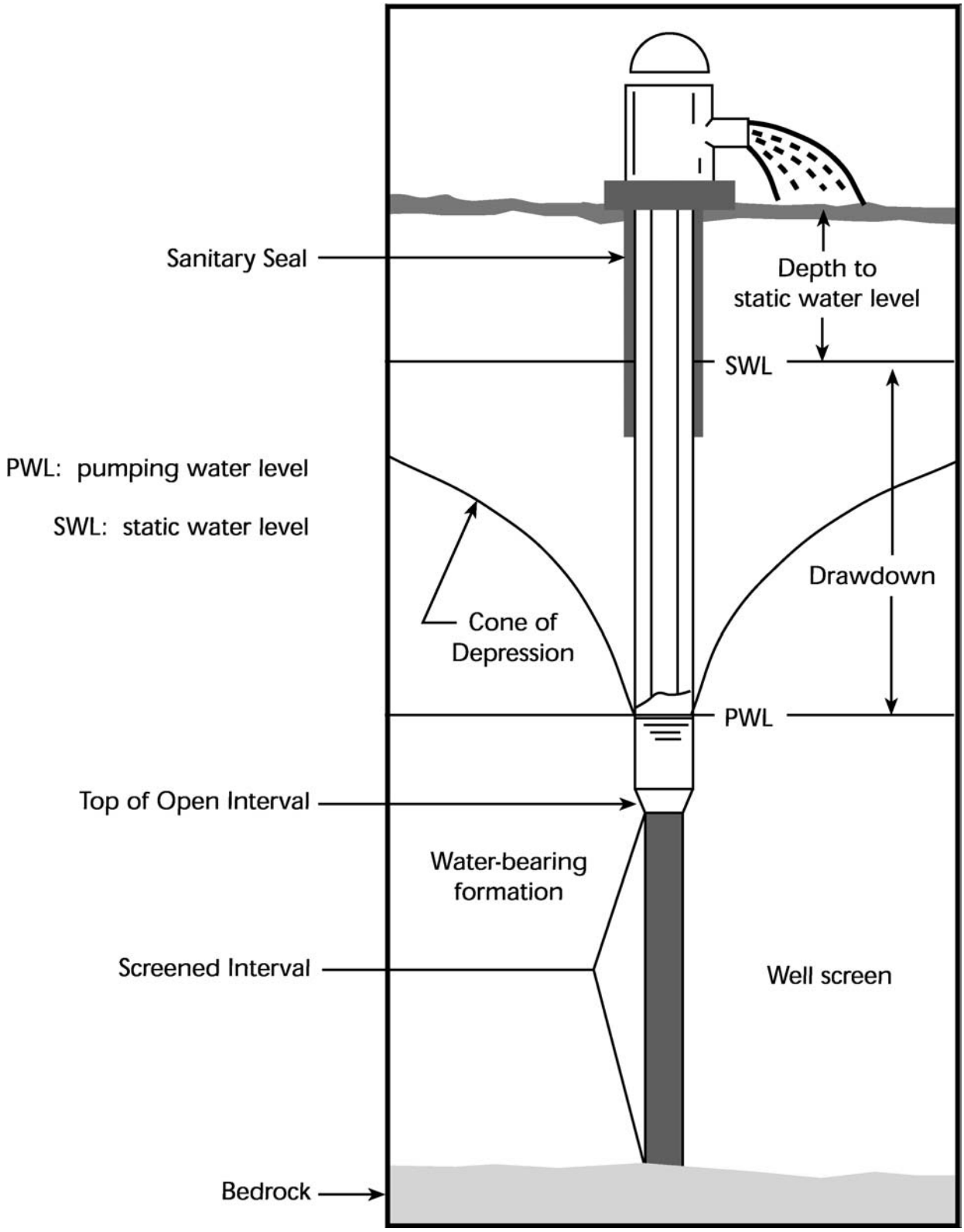
A – source "example well 1"
1 – service station
2 – agriculture; corn, irrigated
3 – abandoned water well

Note that State Highway 167 passes through the 5-year ground water travel time zone on the west. A phone call to the Dept. of Transportation could be made to ascertain whether pesticides are utilized on the highway margins. A highway is also a potential source of VOCs in the form of petroleum product run-off. On the east border of the 10-year ground water travel time zone, the Green River forms a major hydrological barrier.

Example Map


Scale 1 : 14,080 4.5 Inches per Mile
167
Thomas Sch
31
Drive-in Theater
RIVER
2
2
A
1
200
8M
16
3
Golf Course
6
Christopher

Appendix C: Diagram of a Drinking Water Supply Well



Appendix D: Sample Well Report (Well Log)

The following information was taken from the sample well log on the following page.

Date of construction: 2/20/75. If the well report indicates that an existing well is being deepened or reconditioned (box 4) use the most recent date.

Well driller: information found in "well driller's statement"

Well type: drilled well, cable method, found in box 4.

average pumping rate: 100 gal/min yield, found in box 9. Information may also be available on your Water Facilities Inventory form.

Depth to open interval: 107 ft., found in box 6, this is where the depth the casing ends and the screened interval begins.

Depth to ground water: (static water level): 87 ft, found in box 8.

Wellhead elevation: Not completed, in box 8.

Confining layers?: No. There are no impermeable layers such as clay, silt, or glacial till ***above*** the aquifer. In this case, the well log shows that the aquifer is between 103-111 ft in depth, (the screened interval is always located in the aquifer). The static water level (box 8) is exactly 20 feet above the top of the open (screened) interval (box 6).

Surface seal?: 18 ft, found in box 6.

Length of screened interval: 4 ft, found in box 6, the screened interval is 107-111 ft.

WATER WELL REPORT

Original – Ecology, 1st copy – owner, 2nd copy – driller

WASHINGTON STATE DEPARTMENT OF ECOLOGY

Construction/Decommission *("x" in circle)*

○ Construction

○ Decommission *ORIGINAL INSTALLATION Notice of Intent Number* ____________

CURRENT
Notice of Intent No. ____________

Unique Ecology Well ID Tag No. ____________

Water Right Permit No. ____________

Property Owner Name ____________

Well Street Address ____________

City ____________ County ____________

Location ___1/4-1/4 ___1/4 Sec ___ Twn___ R___ EWM or WWM circle one

Lat/Long (s, t, r still REQUIRED) Lat Deg ______ Lat Min/Sec ________ Long Deg ______ Long Min/Sec ________

Tax Parcel No. ____________

PROPOSED USE: ☐ Domestic ☐ Industrial ☐ Municipal ☐ DeWater ☐ Irrigation ☐ Test Well ☐ Other________

TYPE OF WORK: Owner's number of well (if more than one) ________

☐ New well ☐ Reconditioned *Method :* ☐ Dug ☐ Bored ☐ Driven
☐ Deepened ☐ Cable ☐ Rotary ☐ Jetted

DIMENSIONS: Diameter of well ______ inches, drilled ______ ft.
Depth of completed well ________ft.

CONSTRUCTION DETAILS

Casing Installed: ☐ Welded ______" Diam. from ______ ft. to ______ft.
☐ Liner installed ______" Diam. from ______ ft. to ______ft.
☐ Threaded ______" Diam. from ______ ft. to ______ft.

Perforations: ☐ Yes ☐ No
Type of perforator used ____________
SIZE of perfs _____in. by ____ in. and no. of perfs____from _____ ft. to _____ft.

Screens: ☐ Yes ☐ No ☐ K-Pac Location ____________
Manufacturer's Name ____________
Type ____________ Model No. ________
Diam.________Slot size________from________ft. to________ft.
Diam.________Slot size________from________ft. to________ft.

Gravel/Filter packed: ☐ Yes ☐ No ☐ Size of gravel/sand ________
Materials placed from________ft. to________ft.

Surface Seal: : ☐ Yes ☐ No To what depth?________ft.
Material used in seal ____________
Did any strata contain unusable water? ☐ Yes ☐ No
Type of water? ____________ Depth of strata ________
Method of sealing strata off ____________

PUMP: Manufacturer's Name ____________
Type: ____________ H.P. ________

WATER LEVELS: Land-surface elevation above mean sea level ________ft.
Static level ________ ft. below top of well Date ________
Artesian pressure ________ lbs. per square inch Date ________
Artesian water is controlled by ____________ (cap, valve, etc.)

WELL TESTS: Drawdown is amount water level is lowered below static level
Was a pump test made? ☐ Yes ☐ No If yes, by whom? ________
Yield:________gal./min. with________ft. drawdown after________hrs.
Yield:________gal./min. with________ft. drawdown after________hrs.
Yield:________gal./min. with________ft. drawdown after________hrs.

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test ____________
Bailer test________ gal./min. with ________ft. drawdown after ______hrs.
Airtest________ gal./min. with stem set at ________ft. for ________hrs.
Artesian flow ____________g.p.m. Date ________
Temperature of water ______ Was a chemical analysis made? ☐ Yes ☐ No

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information indicate all water encountered. (USE ADDITIONAL SHEETS IF NECESSARY.)

MATERIAL	FROM	TO

Start Date ____________ Completed Date ____________

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

☐ Driller ☐ Engineer ☐ Trainee Name (Print) ____________
Driller/Engineer/Trainee Signature ____________
Driller or trainee License No. ____________

If trainee, licensed driller's Signature and License no. ____________

Drilling Company ____________
Address ____________
City, State, Zip ____________
Contractor's Registration No. ____________ Date ________

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Appendix E: Tables for Calculating the Fixed Radii of Protective Circles Around a Water Source

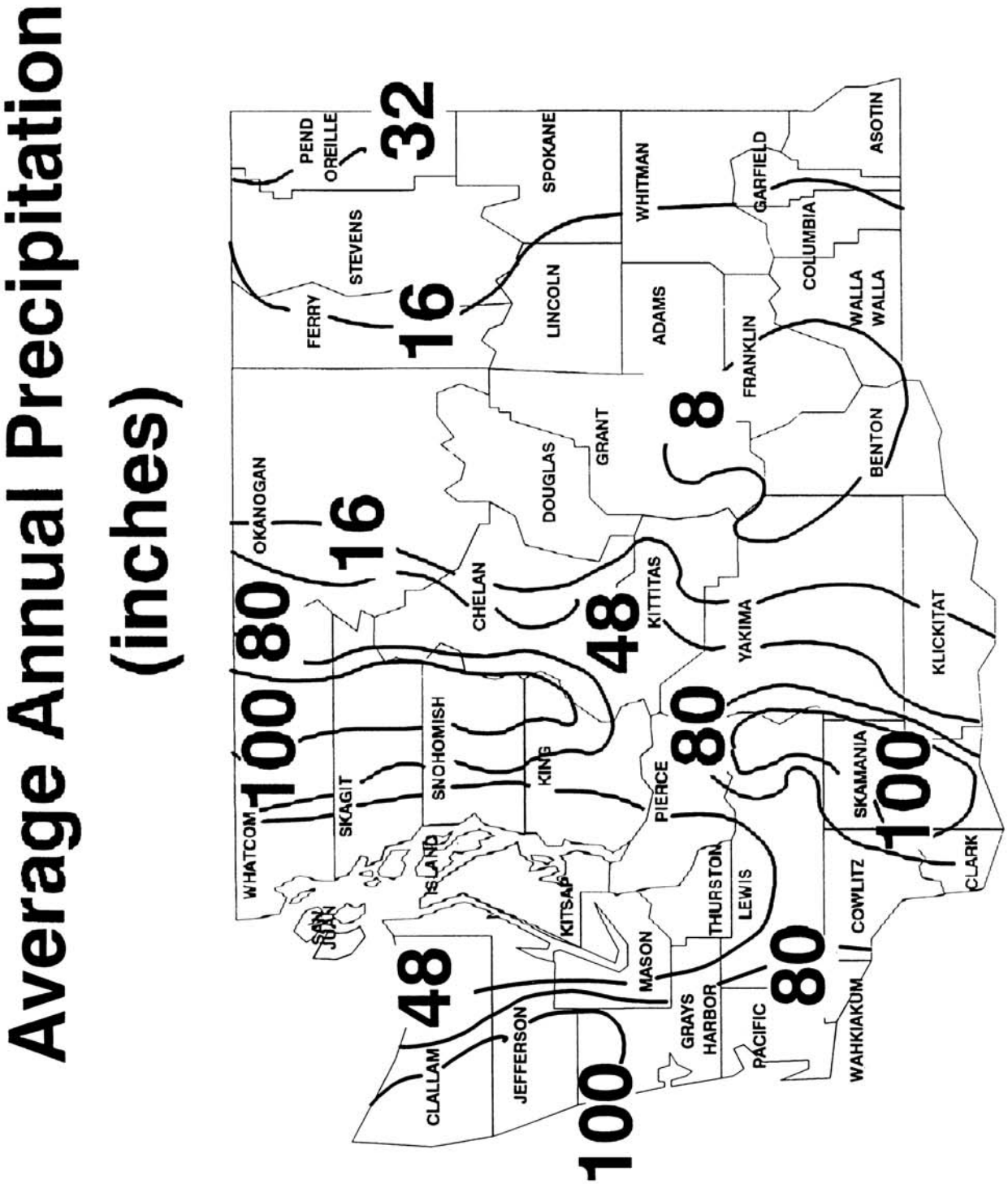
SCREENED INTERVAL = 10ft	Time of Travel			
Annual Volume pumped (GAL)	6 month (radius in feet)	1 year (radius in feet)	5 years (radius in feet)	10 years (radius in feet)
≤ 5,000,000	220	310	700	980
10,000,000	310	440	980	1390
20,000,000	440	620	1390	1970
50,000,000	700	980	2200	3110
100,000,000	980	1390	3110	4400
250,000,000	1550	2200	4920	6950
500,000,000	2200	3110	6950	9830

SCREENED INTERVAL = 25ft	Time of Travel			
Annual Volume pumped (GAL)	6 month (radius in feet)	1 year (radius in feet)	5 years (radius in feet)	10 years (radius in feet)
≤ 5,000,000	140	200	440	620
10,000,000	200	280	620	880
20,000,000	280	390	880	1240
50,000,000	440	620	1390	1970
100,000,000	620	880	1970	2780
250,000,000	980	1390	3110	4400
500,000,000	1390	1970	4400	6220

SCREENED INTERVAL = 50ft	Time of Travel			
Annual Volume pumped (GAL)	6 month (radius in feet)	1 year (radius in feet)	5 years (radius in feet)	10 years (radius in feet)
≤ 5,000,000	100	140	310	440
10,000,000	140	200	440	620
20,000,000	200	280	620	880
50,000,000	310	440	980	1390
100,000,000	440	620	1390	1970
250,000,000	700	980	2200	3110
500,000,000	980	1390	3110	4400

SCREENED INTERVAL = 75ft	Time of Travel			
Annual Volume pumped (GAL)	6 month (radius in feet)	1 year (radius in feet)	5 years (radius in feet)	10 years (radius in feet)
≤ 5,000,000	80	110	250	360
10,000,000	110	160	360	510
20,000,000	160	230	510	720
50,000,000	250	360	800	1140
100,000,000	360	510	1140	1610
250,000,000	570	800	1800	2540
500,000,000	800	1140	2540	3590

Appendix F: Washington State Average Precipitation / Rainfall Map



Appendix G: Phases I/II/V Maximum Contaminant Levels (MCLs)

Contaminants	MCLG (mg/l)	MCL (mg/l)	Potential Health Effects
Phase 1			
1,1-Dichloroethylene	0.007	0.007	Liver/Kidney Effects
1,1,1-Trichloroethane	0.2	0.2	Nervous System Effects
1,2-Dichloroethane	zero	0.005	Cancer
Benzene	zero	0.005	Cancer
Carbon Tetrachloride	zero	0.005	Cancer
p-Dichlorobenzene	0.075	0.075	Cancer
Trichloroethylene	zero	0.005	Cancer
Vinyl Chloride	zero	0.002	Cancer
Phase II			
1,2,4 Trichlorobenzene	0.07	0.07	Liver/Kidney Effects
1,1,2-Trichloroethane	0.003	0.005	Liver/Kidney Effects
1,2-Dichloropropane	zero	0.005	Liver/Kidney Effects
2,3,7,8-TCDD (DIOXIN)	zero	0.00000003	Cancer
2,4-D*	0.07	0.07	Liver/Kidney Effects
2,4,5 –TP	0.05	0.05	Liver/Kidney Effects
Acrylamide	zero	TT	Cancer
Alachlor	zero	0.002	Cancer
Aldicarb Sulfone**	0.001	0.002	Nervous System Effects
Aldicarb Sulfoxide**	0.001	0.004	Nervous System Effects
Aldicarb**	0.001	0.003	Nervous System Effects
Asbestos (fiber > 10um/l)	7MFL	7MFL	Cancer/Lung Tumors
Altrazine	0.003	0.003	Heart/Mammary Glands/Reproductive Effects
Barium*	2	2	Circulatory System Effects
Cadmium*	0.005	0.005	Kidney Effects
Carborfuran	0.04	0.04	Nervous/Reproductive System Damage
Chlorodane	zero	0.002	Cancer
Chlorbenzene	0.1	0.1	Nervous System & Liver
Chromium (total)*	0.1	0.1	Liver/Kidney/Circulatory Disorder
cis-1,2-Dichloroethlyne	0.007	0.07	Liver/Kidney/Nervous System Damage
DBCP	zero	0.0002	Cancer
EDB	zero	0.00005	Cancer
Epichlorohydrin	zero	TT	Cancer
Ethylbenzene	0.7	0.7	Liver/Kidney/Nervous Damage
Heptachlor Epoxide	zero	0.0002	Cancer
Heptachlor	zero	0.0004	Cancer
Lindane	0.0002	0.0002	Liver/Kidney/Nervous/Immune/Circulatory
Mercury (inorganic)*	0.002	0.002	Kidney/Central Nervous System Disorder
Methoxychlor	0.04	0.04	Liver/Kidney/Nervous/Reproductive

Contaminants	MCLG (mg/l)	MCL (mg/l)	Potential Health Effects
Nitrate	10	10	Methoglobinemia
Nitrate	1	1	Methoglobinemia
o-Dichlorobenzene	0.6	0.6	Liver/Kidney Blood Cell Damage
PCBs	zero	0.0005	Cancer
Pentachlorophenol	zero	0.001	Liver/Kidney Effects
Seleium	0.05	0.05	Selonoala
Styrene	0.1	0.1	Liver Effects, Nervous System Damage
Tetrachloroethylene	zero	0.005	Cancer
Toluene	1	1	Liver/Kidney/Nervous/Circulatory
Toxaphene	zero	0.0003	Cancer
Trans-1-2-Dichloroethlyne	0.1	0.1	Liver/Kidney/Nervous/Circulatory
Xylenes (total)	10	10	Liver/Kidney/Nervous System Effects
Phase V			
Adipates	0.4	0.4	Liver/Testes Damage
Antimony	zero	0.006	Decrease Longevity, Altered Blood Levels
Beryllium	0.004	0.004	Bone/Lung Damage
Cyanide	0.2	0.2	Spleen/Brain/Liver Damage
Dalapon	0.2	0.2	Kidney/Liver Damage
Dichloromethane	zero	0.005	Cancer
Dinoseb	0.007	0.007	Thyroid/Reproductive Organ Damage
Diquat	0.1	0.1	Liver/Kidney/Gastrointestinal Tract Damage
Endothall	0.1	0.1	Liver/Kidney/Gastrointestinal/Reproductive Damage
Endrin	0.002	0.002	Liver/Kidney/Heart Damage
Glyphosate	0.7	0.7	Liver/Kidney Damage
Hexachlorobezene	zero	0.001	Cancer
Hexachlorocylopentadiene	0.05	0.05	Kidney/Stomach Damage
Nickel	0.1	0.1	Heart/Liver Damage
Oxamyl	0.2	0.2	Kidney/Liver
PAHs (Benzo(a)pyrene)	zero	0.0002	Cancer
Phthalates	zero	0.006	Cancer
Picloram	0.5	0.5	Kidney/Liver Damage
Simazine	0.004	0.004	Cancer
Thallium	0.0005	0.002	Kidney/Liver/Brain/Intestine Damage

Notes:

* Indicates original contaminants with interim standards that have or will be revised.

** Regulation currently not in effect.

TT= Treatment Technique

MFL= Millions of Fibers per Liter